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NOVEMBER, 1955

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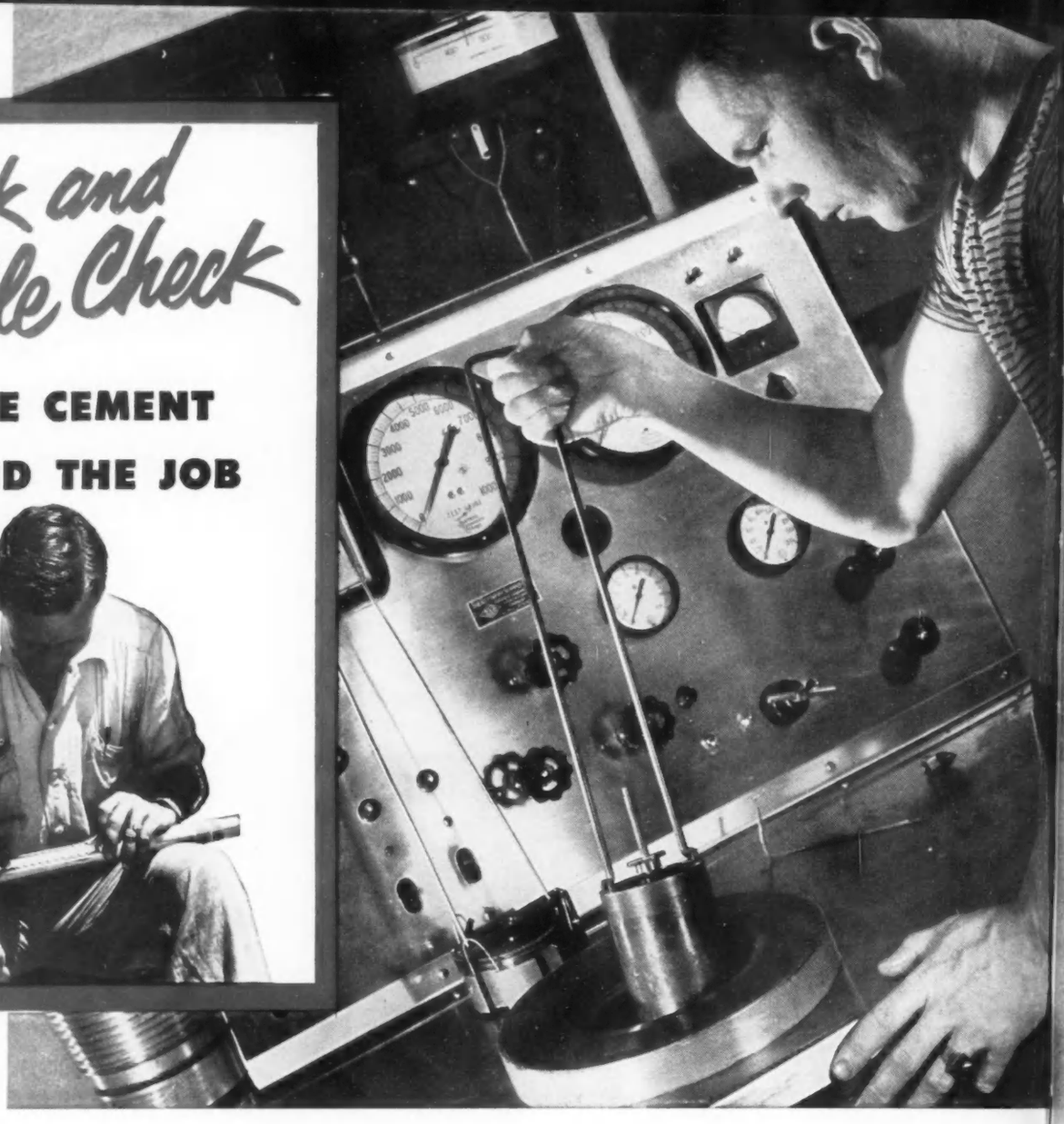

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Vol. 141, No. 6

November, 1955

WORLD OIL

Established 1916 as The OIL WEEKLY

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a quick look at WORLD OIL THIS MONTH

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

CURRENT OUTLOOK

☐ **Oil producers in the U. S. face a difficult task** in finding and supplying enough oil to meet the growing demand. Not only are fields harder and costlier to find, but also the domestic consumption of oil continues to increase steadily. This poses a real problem in maintaining reserves. The demand for oil in the U. S. will expand even more in the next 10 to 20 years. Outside the U. S., demand will continue to increase even more sharply. The industry will have to work hard and

Turn the Page

THIS MONTH . . .

exercise all its ingenuity to keep abreast of requirements. Turn to **Page 64** for what an outstanding industry leader has to say on the subject. **Meeting Future U. S. Oil Needs to Be a Tough Job.** . . . . . **Albert L. Nickerson**

☐ **More wells and more footage must be drilled annually.** This is the prospect facing drilling contractors and others. In order to meet the prospective steadily increasing demand for petroleum products, there must be further expansion of drilling volumes beyond their current large proportions. Activity must be vigorous in the U. S. to maintain and increase domestic crude production. Development also will increase in other countries, as oil consumption is increasing more sharply abroad than in the U. S. For predictions of volumes of crude production and drilling to be expected in the next 10 to 20 years, see **Page 68. Increased Use of Oil to Require More Drilling.** . . . . **Warren L. Baker**

☐ **Will oil and politics mix?** They *must,* says Sen. Robert S. Kerr (D-Okla.). The senator says that in the very near future, politics and politicians will determine to a large extent the survival and progress of the oil industry. Turn to **Page 72** for a discussion of the political areas vitally affecting the oil industry. **Why Oil and Politics Must Mix.** . . . . . **Sen. Robert S. Kerr**

☐ **Substantial savings can be realized** by small and medium-sized companies by mechanizing bookkeeping procedures. Such mechanization can be attained on a single accounting machine at considerably less cost than the most economical pen-and-ink system. One typewriter-bookkeeping machine handles all major bookkeeping requirements for one company in Dallas. Records are made more accurate, legible, and up to date. And the job is done with three fewer employes than needed using older methods. Some of the actual bookkeeping machine operations of this company are outlined in the article beginning on **Page 74. Machine Accounting Cuts Costs. H. C. Martin and L. K. Newton**

☐ **Oil industry records are being broken** and forecasts are being exceeded. That's the way the year 1955 looks now. A sharp gain in demand for petroleum products is taking place. To meet this demand, the industry is operating at appropriately high rates in producing crude and in running crude to refinery stills. Excesses are being avoided fairly well, and supply is being held in line with demand. The industry meanwhile proceeds with its usual vigorous growth to assure that the higher oil demands of the future will be supplied. **1955 . . . a Good Year for Oil.** . . . . . **Page 82**

☐ **What about 1975.** An interesting sidelight to current industry trends occurred when a cross-section of business leaders . . . including the oil industry . . . uncovered their crystal balls and took a look at 1975. **Industry Leaders Take a Look at 1975. Page 86**

☐ **A recently-enacted anti-pollution law** threatens to bring about the abandonment of thousands of marginal wells in Oklahoma, particularly in the Greater Seminole area. Here is a discussion of the operators' viewpoint including the economics involved. This article should help operators understand the situation and may contribute toward a compromise with Oklahoma state regulatory bodies which will result in effective disposal of deleterious oil field wastes without abandoning thousands of wells. **Anti-Pollution Law a Threat to Oklahoma Oil Men.** . . . . . **Page 92**

EXPLORATION ARTICLES

☐ **Recent discoveries** along the eastern platform of West Texas indicate the development of an important trend in Cambrian-type production. The article beginning on **Page 99** reviews and evaluates three recent discoveries and points up the correlation similarities of the various fields as shown in gamma ray and neutron logs. **Cambrian Production Opens New Trend in West Texas.** . . . . . **Aaron W. Cook**

☐ **The use of micro-organisms as indications of petroleum deposits** appears to be sound. But samples taken must be representative of the given area for the results to have quantitative significance. Turn to **Page 104** for a description of a quantitative microbiological procedure which can be used for the detection of hydrocarbon gases in subsoils. **A Microbiological Method of Prospecting for Oil.** . . . . **Dr. R. J. Strawinski**

DRILLING ARTICLES

☐ **How do compressors contribute to the success of air drilling?** Beginning on **Page 119,** you'll find the first part of series describing the types of compressors available today and an explanation of how their size, capacity, number of stages, type of power drive and horsepower requirements contribute to the success of air drilling. **What Every Contractor Should Know About Compressors for Air Drilling (Part 1).**
James T. Morris and Robert T. Ramsey

Looking Ahead . . .

. . . **Oil industry must be ever defense-minded,** giving thought to protection of its facilities and maintenance of its vitally essential operations in event of war. Russians are building more war ships than rest of the world combined. Their offers to sell military supplies to Middle East, South American and other countries invite wars and point up insecurity of Middle East and other oil sources of free world.

. . . **The higher compression ratios of the 1956 automobiles will be felt in the oil industry,** and soon. The big boost in compression ratios will mean a heavier demand for higher octane gasoline. This in turn will increase the need for crude oil because, as the octane ratings go up, gasoline yields go down.

. . . **Another 800,000 home owners will be using natural gas for heating purposes** for the first time this winter, according to the Natural Gas Association. It figures 15,212,000 homes will use gas for heat in the 1955-56 season as compared with an estimated 13,400,000 last winter. The Association estimates there will be around 16½ million customers for gas by the 1957-58 heating season.

. . . **U. S. must encourage more youngsters to become scientists and engineers** if it is to develop and support weapons of tomorrow needed to survive, declared Admiral Arthur W. Radford, chairman of Joint Chiefs of Staff. Communists are educating twice as many scientists as U. S.

. . . **A move is building up in oil producing states to spread the tax structure** to meet increasing needs for funds for education and the fringe benefits of government. Oil industry's output cannot keep pace with the growth of governmental costs. The time has come when financing of schools must be tied to some revenue-producing factors more accurately related to population growth, expanding real estate values and booming commerce.

. . . **Oil companies will be able to carry out only limited additional expansion** of facilities with aid of five year write-offs of costs. Office of Defense Mobilization will grant such aid to refiners until an additional 250,000 barrels per day is added to U. S. refining capacity. Also eligible for fast write-offs will be pipe lines and tankers. ODM briefly suspended all fast write-offs, but has resumed them for 32 industries important to national defense.

. . . **Oil development off the Louisiana coast will be retarded by further litigation over tidelands ownership.** U. S. Supreme Court recently denied plea of Federal government that Louisiana's boundaries be fixed at three miles from land. But decision did not necessarily uphold Louisiana's claim to belt extending out three leagues (10½ miles). Some oil companies meanwhile hold federal leases on limited acreage claimed by both U. S. and Louisiana.

. . . **Though supplies of steel, copper and aluminum will continue tight into 1956, actual needs generally will be met.** And allocations by suppliers will prevent black markets or premium prices. Within 1 or 1½ years, scarcities could fade through larger steel-making capacity and possible slackening of general business activity. Drilling, pipe line building and refinery construction will not be appreciably retarded for lack of metal goods.

. . . **Oil industry probably can safely expect demand for its products to increase** at least 3 percent or 4 percent annually in the years ahead. U. S. population is increasing nearly 2 percent annually, and oil use per person steadily rises, due to more oil-using units and growing use per unit. An extra stimulant to oil demand is the fact oil is supplying an increasing percentage of total energy requirements.

. . . **While atomic energy still is in the process of being developed into practical use,** another promising form of usable energy is in embryo stage. At Americus, Ga., the Bell Telephone Laboratories are putting to practical test their solar battery. It will take sunlight and change it into electricity to supply power to rural telephone lines. Atomic and solar energy promise to supplement though not supplant oil, gas, coal and water power.

. . . **Introduction of turbine engines into heavy vehicles already is justifiable.** And a substantial number of passenger vehicles will be equipped with turbos within ten years. All advanced military aircraft are being equipped with gas turbine engines, either turbojet or turboprop type. Latter is hailed as a strong competitor to the piston engine in commercial aviation. Gas turbines are used successfully in locomotives, compressors, generators, pumps and blowers. However, gas turbines must compete with piston engines which will be further improved—more compact, more efficient, of increased compression ratio and of higher horsepower.

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The API Serves You

The annual meeting of the American Petroleum Institute will convene in San Francisco in mid-November. Those attending will appreciate that it is a big affair. This will be impressed upon them by an attendance in excess of 6000, and by their contact with some of the numerous committee meetings, group sessions or general sessions.

However, even these people are not likely to realize the tremendously varied and wide scope activities of the Institute. Few people other than the 130 oil men who make up the Board of Directors actually realize the scope of the Institute's activities or the size of the organization required to administer and direct its vast operations. This is because so few oil men have an opportunity to come in contact with more than just a small portion of the Institute's activities.

Because so few actually have an understanding of the Institute's over-all activity and operations, the forthcoming annual meeting constitutes an excellent time for oil men everywhere to stop for a few moments and think about the many ways the API attempts to serve the oil industry.

•

The Institute is the industry's largest forum, information bureau, and technical clearing house.

In addition to the annual meeting, many other meetings will be held by the various divisions and departments of the Institute during the course of a year. These will range from national to district and even local level. More than 150,000 oil men will attend these various API meetings during 1955, although attendance at any one of them will seldom exceed 1500. Many of them will have only a few hundred in attendance.

These meetings, however, constitute only a part of the API work. Most of the Institute's activity is done at committee level, with the membership made up of men from the industry. For example, approximately 160 separate committee meetings will be held during the annual meeting in San Francisco. Many other committee meetings are held at other times during the year, and much is accomplished by correspondence with committee members throughout the year.

It is impossible to describe all the API's activities. Essentially, they might be classified as in the fields of equipment standardization, design and care of equipment, all phases of engineering and technology, fundamental research, safety and fire protection, waste disposal, nomenclature, metallurgy, corrosion control and prevention, all transportation phases, fuels and lubricants, agriculture, highway construction, aviation, vocational and personnel training, education and public relations, finance, accounting, statistics, petroleum reserves, taxation, legislation, and government regulation.

The API setup, as previously mentioned, consists essentially of committees and their subcommittees. So as to have a workable organization that can handle all these matters in an efficient manner, the institute is divided into executive functions; four operating divisions of production, refining, transportation and marketing; and a number of service departments, such as the Department of Information, the American Petroleum Industries Committee, the Department of Statistics, and the Department of Technical Services.

•

A big staff of paid personnel is required to handle all the affairs and activities of the Institute, although so much of its work is done by volunteers from the industry serving on numerous committees.

Therefore, the Institute itself constitutes a big business operation. It has a total of 325 paid employes at its offices in New York, Washington, Dallas, Los Angeles, and in the field offices of the Oil Industry Information Committee and the American Petroleum Industries Committee. Its annual budget for all activities now reaches $7 million.

The paid staff of the API works mainly in an administrative capacity, working as a service organization for the Board of Directors and its Executive Committee, and for the Institute's many, many divisional and departmental committees. Each of the Institute's four divisions and different service departments is headed by a director, and the necessary staff of assistants and clerical help.

Don't think of the API as performing only the operations with which you are familiar. Nine chances out of 10 it is engaged in many activities that you do not know about.

Warren L. Baker

Meeting Future U. S. Oil Needs to Be a Tough Job

- U. S. producers may find it increasingly difficult to meet the growing demand.
- We're not "running out of oil," but it's getting harder to build reserves. This is true not only because oil is getting harder to find, but because the need for it is increasing so rapidly.
- Oil use in the Free World outside U. S. is increasing even more sharply, and will equal demand in U. S. in 10 years.
- Crude output in Free World outside U. S. has caught up with U. S. production this year.

By ALBERT L. NICKERSON, President
Socony Mobil Oil Company, Inc., New York

THE NEXT 10 to 20 years are likely to be years of steadily increasing demand for petroleum in the U. S. and abroad. And although demand will increase less sharply in the U. S. than in the remainder of the Free World, U. S. producers probably will find it increasingly difficult to meet the enlarged domestic demand. The demand will climb materially above current levels, in spite of the indications that nuclear energy eventually will supply a relatively small proportion of total energy requirements.

Although it is currently stated that the U. S. has a reserve producing capacity of 2 million barrels a day, this position has been achieved only through the past eight years of progressively higher drilling rates. And on the basis of experience during and immediately following World War II, it is indicated that this 2 million barrel estimate of reserve capacity actually is too high; that the real reserve productivity for a sustained period may be only about 600,000 barrels a day. This lower figure is indicated by the fact that in the war period, with production at maximum efficient rates, the annual output never materially exceeded 8 percent of U. S. reserves.

To provide adequate petroleum supplies for all the expected require-

About the Author

ALBERT L. NICKERSON became president of Socony Mobil Oil Company several months ago. He previously was vice president and director in charge of foreign marketing for Socony. Nickerson began work with the company as a service station salesman in 1933, shortly after graduation from Harvard. He was promoted through sales positions until in 1941 he became New England division manager. In 1944 he became assistant general manager of the Eastern marketing division, and in 1944 he went to England as chairman of Vacuum Oil Co., Ltd. In 1946 he returned to the U. S. and was made a director of Socony-Vacuum, and in 1951 he became head of foreign marketing operations. He was born in Dedham, Mass., and was graduated from Noble and Greenough School in 1929, before entering Harvard.

ments of the next 10 to 20 years, the industry must meet further tests of its justly earned reputation for ingenuity, continued technological advancement, and tireless, hard work.

1954-1955 Demand. Demand for liquid hydrocarbons in the U. S. in 1954 amounted to about 7,750,000 barrels a day, an increase of only 2 percent from the previous year. In the beginning of 1954 an increase of 4 percent was expected, and the lesser increase came as a disappointment. Domestic production was slightly less than in the previous year.

This year the reverse situation seems to be occurring. Demand is running ahead of earlier estimates, and may exceed 8,300,000 barrels daily, an increase of over 7 percent. Gasoline demand in August was 9 percent ahead of August 1954, an exceptionally good showing; and distillate fuels are running over 9 percent ahead for the first eight months. Domestic production is ahead 5.6 percent for the same period.

As we stand at the threshold of the heating season we have the same worries we always have at this time of year. Are stocks too high? Are runs too high? Will cold weather stimulate demand soon enough? No one knows the answer to these questions. It looks as though the industry is in good shape to meet the heating load if we have normal weather in the heavy consumption areas. And if we have, we should all enjoy good business. We must plan for normal weather. The public will forgive us if during a warm winter our tanks overflow and our prices drop. It will not forgive us if we fail to meet the demand during a colder than normal winter.

U. S. Demand Forecasts. Looking ahead to 1956, our company forecasts total domestic demand at 8,650,000 barrels daily, a further increase of 4 percent over 1955.

On the basis of estimates made by our company, we expect steady growth in domestic demand during the decade 1956-1965. Our estimate for 1960 is 9,700,000 barrels daily, or an increase of nearly 17 percent over 1955. And for 1965 we forecast an additional 10 percent increase over 1960.

If we compare today's demands for individual petroleum products with those forecast for 1960, a number of shifts in the pattern of oil consumption in the U. S. appear to be in prospect. On a percentage basis, the most striking of these is a gain of 93 percent in demand for jet fuel, reflecting the replacement of conventional piston engines by turbojet and jet engines in military and civilian aircraft. By 1960 demand for jet fuel is forecast at over 300,000 barrels a day. Our forecasts indicate increases of about 44 percent in demand for asphalt and of about 39 percent in demand for liquefied petroleum gas in the same period.

We expect demand for gasoline to rise at about the same rate as total domestic demand over the next 5 or 6 years. Demand for distillates, we think, will increase more sharply. On the other hand, demand for kerosine in 1960 is expected to be smaller than it is today. And our forecast indicates demand for residuals will remain almost stationary.

TABLE 1—Estimated U. S. Domestic Demand for Petroleum in Coming Years

Year	Bbls. Daily	Increase
1954.....	7,750,000	2% Over 1953
1955.....	8,300,000	7% Over 1954
1956.....	8,650,000	4% Over 1955
1960.....	9,700,000	17% Over 1955
1965.....	10,670,000	10% Over 1960
1975.....	12,282,000	15% Over 1965

TABLE 2—Expected U. S. Domestic Demand for Some Individual Petroleum Products in 1960 as Compared With 1955

Product	Increase, 1955-1960
All Oils	17%
Jet Fuel	93% (to 300,000 bbls. daily in supplying military and civilian aircraft)
Asphalt	44%
Liquefied Petroleum Gas	39%
Gasoline	Average gain
Distillates	Above average gain
Kerosine	(Decrease)
Residuals	No change

TABLE 3—Forecast of Demand for Oils in Free World Outside U. S.

Year	Bbls. Daily	Increase
1954.....	5,300,000	.....
1955.....	5,883,000	11% Over 1954
1956.....	6,350,000	8% Over 1955
1960.....	8,300,000	41% Over 1955
1965.....	10,707,000	29% Over 1960
1975.....	14,418,000	35% Over 1965

Outlook for individual products: Continued strong markets for distillates and residuals; sharply higher demand for jet fuel; gasoline use retarded by high taxes, as heretofore.

TABLE 4—Estimates of Total Free World Demand for Oils in Coming Years

Year	Bbls. Daily	Increase
1954.....	13,050,000	.....
1955.....	14,183,000	8.7% Over 1954
1956.....	15,000,000	5.8% Over 1955
1960.....	18,000,000	27% Over 1955
1965.....	21,377,000	19% Over 1960 65% Over 1954
1975.....	26,700,000	25% Over 1965

Outside U. S. Turning to the free world outside the U. S., we estimate that demand for liquid hydrocarbons amounted to a little more than 5,300,000 barrels a day in 1954. Our forecast for this year is for an 11 percent increase, and next year we expect a further increase of 8 percent.

In the decade 1956-1965 demand in the free foreign countries is expected to rise much faster than in the U. S. By 1960, our forecast indicates that demand will reach 8,300,000 barrels a day, an increase of almost 41 percent over this year. By 1965 the demand is estimated to be 29 percent above the level five years earlier.

Starting from a lower base but climbing at a sharper rate, we estimate that demand in the free foreign countries will just about equal U. S. demand in 10 years. Crude production in the free world outside the U. S. caught up with U. S. production this year.

The large increases in petroleum demand in prospect for the free foreign countries reflect the notable progress made by most of these countries in solving the difficult problems of post-war reconstruction. In Western Europe particularly, economic recovery has been very rapid in the last two or three years. All of the countries in this area are even now much better off than they were before World War II. Industrial plants have been modernized and industrial production is

"It does not seem likely that petroleum will be challenged during our lifetime for its largest and most valuable market—automotive fuel."

far above pre-war levels. As Americans, we can be justly proud of our contribution to this recovery. Without our help in the form of economic and military aid, it might well not have taken place. The political repercussions in this event would have been of the utmost gravity.

The pattern of product consumption abroad is basically different from that in the U. S., and our forecasts of demand lead us to believe that it is likely to remain so for some time. Residual fuel oil is in greater demand abroad than any other product, whereas in this country gasoline demand is more than twice as large as demand for residuals. Extraordinarily high taxes on gasoline, levied to save foreign exchange and to raise internal revenue, have discouraged its consumption in virtually all foreign countries. Our estimates of products demands in the free foreign countries during the next several years indicate continued strong markets for distillates and residuals, with a sharp increase in the demand for jet fuel.

Free World Total. Adding U. S. demand to that of the rest of the free world, we have a total free world daily demand for liquid hydrocarbons spiraling from 13,000,000 barrels in 1954 to 21,400,000 barrels in 1965—an increase of 65 percent.

An oil producer operating in Texas in October, 1955, on a 16-day producing schedule might consider these figures a little remote. But the probability of continued strong demand for petroleum products over the next decade, not only in the U. S., but throughout the free world, should be a source of real encouragement to all.

Demand in 1975. Before leaving the subject of demands, let's project them for one more decade, to 1975. That after all isn't any farther away than 1935, and to many of us that doesn't seem very long ago.

Our forecast of total free world demand in 1975 is 26,700,000 barrels a day, 25 percent more than in 1965. Forty-six percent of this total demand will occur in the U. S. and the balance, 54 percent, abroad.

Nuclear Energy. In making these long-range forecasts, we have tried to take into account the development of nuclear energy.

Scientists have pointed out that some parts of the world, remote from conventional fuel sources, could even now be economically served by nuclear electric power plants. They expect that nuclear generating costs can be reduced sufficiently by about 1965 to make nuclear power competitive in many areas.

There will probably be a gradual shift from conventional fuels to nuclear fuels as new electric power stations are built and as nuclear power becomes increasingly competitive. There doesn't seem to be much likelihood that present power stations will in the foreseeable future convert to nuclear fuels. So to the petroleum industry this will mean initially that the demand for its least valuable product —residual fuel oil—may not rise as rapidly in the future as it otherwise would have.

Next on the timetable may be the use of nuclear fuels to propel ships and to provide central heat and energy sources for industrial operations. The *U.S.S. Nautilus* is now operational, and other nuclear-powered submarines are under construction. The petroleum industry can expect eventually to lose some of its potential markets for diesel fuels as well as for heavy fuel oils.

Some time between 1965 and 1975 technological advances may also make nuclear electricity economical in some areas as a central source of heat for homes and power for railroads.

It does not now seem likely that petroleum will be challenged during our lifetime for its largest and most valuable market—automotive fuel. Before nuclear fuel can be used directly in small or moderate-sized mobile power plants, the immensely difficult problem of safe packaging must be overcome. Our important asphalt market will be unaffected by nuclear developments and, so far as can now be seen, nuclear energy does not threaten our markets for lubricants.

And of course we have our rapidly expanding field of petrochemicals. The fact that this field now accounts for but a small fraction of total crude runs should not cause us to forget that annual sales value has doubled since 1950 to nearly $4 billion, and that today 25 percent of all chemicals made in the U. S. are derived from oil and gas refinery streams and from natural gas. Within the next ten years this figure may jump to as high as 50 percent.

As a matter of fact, if nuclear power becomes an economic reality, the possibility of great increases in the standard of living and a corresponding expansion in man's use of energy, especially in areas presently remote from deposits of coal or oil, might well promote new uses for petroleum that would tend to offset those uses that might be lost to the atom.

In the face of uncertainties about nuclear energy, the best brains within and outside the oil industry, predict a steadily rising rate of liquid fuel consumption throughout the free world through 1975.

Besides releasing heat, the process of nuclear fission also produces radiation. By the irradiation of hydrocarbons, changes are brought about that can not be obtained in any other way. If the refiner can control and direct these chemical changes he may develop some entirely new and different refining processes and products from crude oil. This may result in more efficient and less expensive petroleum processing, better products and new products, thereby stimulating still further the demand for both crude and natural gas.

Meeting Future Needs. The demand forecast cited above indicated that 10 years from now, in 1965, with nuclear energy still a fledging commercially, we shall need in the U. S. 3 million more barrels of liquid hydrocarbons daily than we did last year. Twenty years from now, in 1975, when nuclear energy is expected to be a more important contributor to the total energy supply, nearly 4½ million barrels daily more than last year will be required. This increase alone is well over half of last year's consumption.

Will the petroleum industry of the U. S. be able to carry its share of the load in meeting the energy supply problems of the future?

Demand for liquid hydrocarbons forecast for the U. S. over the 10-year period 1956-1965 amounts to nearly 36 billion barrels, almost exactly the same as this country's present proved reserves.

The statement that we're running out of oil is as misleading today as it always has been before. But it's getting harder and more expensive to build up our reserves. This is true not only because oil is becoming harder to find but because our need for it is increasing so rapidly.

Since the end of World War II the domestic industry has undertaken the biggest drilling program in its history. Since 1946, the proved reserves of the U. S. have increased by one half —from 24 to about 36 billion barrels.

In spite of this unprecedented drilling effort, the U. S. share of the proved reserves of the free world has declined significantly since the end of the war—from 38 percent at the end of 1946 to about 20 percent at the end of 1954. This relationship is not expected to improve. Our forecast indicates that by 1960 the domestic industry will be producing one-half of the Free World's oil from only one-fifth of the proved reserves.

On a footage basis the domestic industry is doing six times as much exploratory drilling now as it did in the years 1939 through 1941, just before we entered World War II. In spite of this increased oil-finding effort, new reserves resulting from wildcat discoveries have not quite doubled. The major additions to our reserves continue to come, not from discoveries of new oil fields, but from development and extensions of old fields and from revised estimates of the oil to be recovered from existing fields as a result of better-than-expected performance, unitization, and the application of improved recovery practices. And new fields being discovered these days appear to be smaller on the average than those found in the past.

In the five years before World War II the domestic industry was adding about two barrels to the country's crude oil reserves for every barrel of crude produced—leaving a net gain in reserves of one barrel. Since the war the ratio has been declining. Over the last five years the average has been less than one and a half barrels of reserves for every barrel produced, so that the net gain in reserves during this period has been less than half a barrel for every barrel produced.

Still another measure of success in building up reserves is the ratio between footage drilled and additions to reserves. Since the beginning of 1937 an average of 23 barrels of oil has been added to reserves for every foot of hole drilled. In the nine pre-war and war years the ratio was considerably above this average. In the nine-year period 1946 through 1954, the ratio has been below this average.

" . . . by 1960, the domestic industry will be producing one-half the free world's oil from only one-fifth of the proved reserves."

Unless these trends can be reversed, producers in the U. S. will find it increasingly difficult to meet the large future demand for petroleum.

Producing Capacity. The U. S. now may have a reserve producing capacity of some 2 million barrels a day. This reserve capacity has been built up over the last eight years, and has been accompanied by a progressively higher drilling rate. It seems probable that this upward trend in drilling will continue for several years. Because reserve capacity is so vital to national defense, however, it is important that the meaning of this 2 million barrel figure should not be misunderstood.

During and immediately after World War II, when the domestic industry was producing oil at maximum efficient rates of production, the annual rate of production never significantly exceeded 8 percent of U. S. reserves. It may fairly be assumed then that this figure of 8 percent was at or very near the upper limit imposed by the efficient productivity of our wells at that time. If we were faced with a similar situation today the strong probability is that we would not be able to produce more than 8 percent of our total proved reserves each year on a sustained basis.

For example, if our 1954 total domestic producing rate had been increased during the whole year 1954 by the 2 million-barrel daily excess producing rate already referred to, we would have been producing our reserves at an annual rate of 9½ percent—and it is unlikely that this rate could be maintained for any prolonged period. The 2 million-barrel figure may represent the country's reserve capacity to produce oil at any given time, but it probably does not accurately measure our ability to produce for any period longer than a few months.

Last year the industry produced 2,560,000,000 barrels of oil and natural gas liquids in the U. S. Eight percent of our reserves would be 2,780,000,000 barrels. The difference between these figures is 220 million barrels, or 600,000 barrels a day. This may represent the country's approximate reserve producing capacity at MER over any sustained period, and may be a more realistic figure of a dependable reserve productivity than the 2 million-barrel figure so often referred to.

Must Develop More Oil. There is nothing sacred about this figure of 600,000 barrels a day. It is the result of a calculation in which the actual experience of the 1940-1946 period is projected into the immediate future. However, as such, it merits very careful consideration and justifies a few further remarks and projections.

Over the five-year period 1950 through 1954, the domestic industry has proved an average of 3,760,000,000 barrels of petroleum in the U. S. each year. This figure includes both actual production and net additions to reserves.

If we assume that oil is imported into the U. S. during the decade 1956 through 1965 at the rates recommended earlier this year by the Cabinet committee appointed by President Eisenhower, and if we assume also that the 8 percent ratio between production and reserves is maintained over this same period, it follows that we would then need to prove an average of 4,100,000,000 barrels a year over the decade in order to meet domestic demands forecast for those years.

From this point of view, then, during the next 10 years, production plus net additions to reserves, whether from new discoveries or from additions to known fields, would have to be stepped up by an average of 340 million barrels a year over the average for the last five years.

On the same basis, the average annual requirement for the decade 1966 through 1975 would be 4,370,000,000 barrels. This is 610 million barrels a year more than the average for the last five years.

ACKNOWLEDGMENT

An abridged version of an address presented before the Texas Mid-Continent Oil and Gas Association at Dallas, October 4, 1955.

Increased Use of Oil To Require More Drilling

• Sharply higher demand for petroleum 10 and 20 years from today will require the drilling of far more wells and footage annually.

• Industry must supply increasing numbers of automobiles, trucks, buses, airplanes, farm tractors, factories, and diesel locomotives.

• New uses for petroleum are being developed constantly, as exemplified by synthetic rubber, fertilizers, plastics, detergents and numerous other petrochemicals.

By WARREN L. BAKER, Editorial Director, WORLD OIL

THE REMARKABLE growth of the drilling business during the last 10 years will continue in coming years. Far more wells and footage will be drilled annually than ever before.

Prospective oil needs are such that contractors can look forward with confidence to a steady increase in U. S. drilling activity. Enlarged producing needs 10 and 20 years hence are certain to require the drilling of far more wells and footage than present peaks.

The future also will see more drilling for oil in other countries, although the volume will remain small in comparison with U. S. drilling rates. This will become increasingly important to drilling contractors, recent years having seen a growing number of U. S. contractors engage in operations in other parts of the world. This trend is likely to continue.

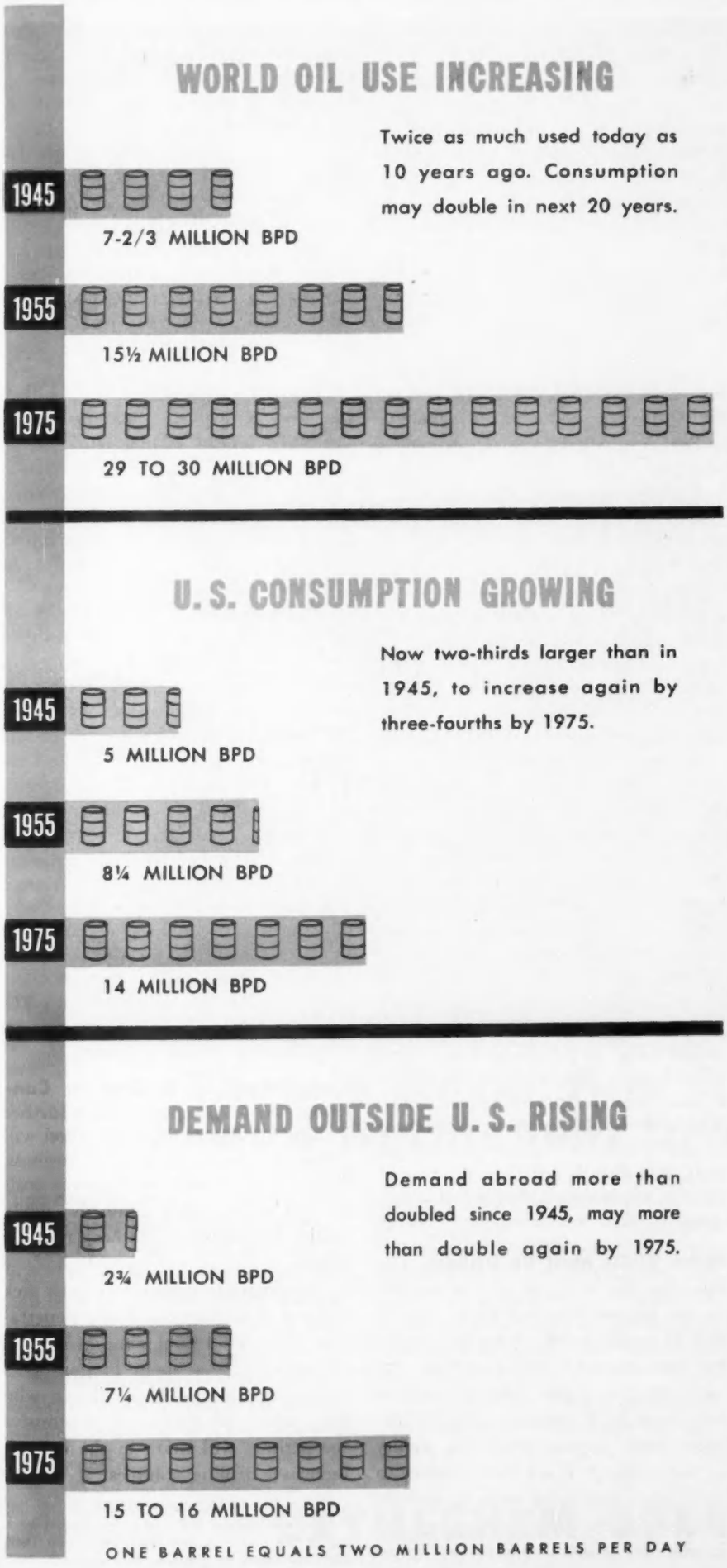
More Oil to Be Needed. The overall outlook for oil is extremely bright. Further vigorous growth lies ahead of the industry. Future expansion is likely to equal the record-shattering pace of the past decade.

This bright prospect is created by the expectation that consumption will continue growing at the same amazing rates as in the last 10 years. Consequently, there will be a need to produce far greater quantities in coming years. Despite present excess producing ability, enough oil to satisfy enlarged future needs can be provided only by larger drilling rates and the vigorous installation of new producing facilities. It naturally follows that pipe line and refining capacities also will need to be enlarged by equally substantial volumes.

Consumption Boom Ahead. Many factors indicate that there will be no interruption in the miraculous growth in oil consumption for many years. The world's population will grow faster than ever before. Per capita consumption will rise throughout the world, as many countries become more heavily industrialized and mechanized. There will be more homes to heat. Likewise, there will be more automobiles, trucks, buses, planes, farm tractors, factories, and railroad locomotives using oil.

Furthermore, new uses for oil and gas are being developed constantly. Dieselization of American railroads is largely a postwar development. Jet airplane fuel was unheard of 10 years ago. Synthetic rubber is a war development. The manufacture of synthetic cloth fibers, fertilizers, plastics, detergents, ethers, alcohols, and all the other numerous petrochemicals are new industries based on oil and gas.

The world is using twice as much oil now as 10 years ago, and is likely to again double its consuming rates during the next 20 years. By 1975 world demand probably will reach 29


WORLD OIL USE INCREASING
Twice as much used today as 10 years ago. Consumption may double in next 20 years.
1945
7-2/3 MILLION BPD
1955
15½ MILLION BPD
1975
29 TO 30 MILLION BPD
U. S. CONSUMPTION GROWING
Now two-thirds larger than in 1945, to increase again by three-fourths by 1975.
1945
5 MILLION BPD
1955
8¼ MILLION BPD
1975
14 MILLION BPD
DEMAND OUTSIDE U. S. RISING
Demand abroad more than doubled since 1945, may more than double again by 1975.
1945
2¾ MILLION BPD
1955
7¼ MILLION BPD
1975
15 TO 16 MILLION BPD
ONE BARREL EQUALS TWO MILLION BARRELS PER DAY

to 30 million barrels per day. Current world consumption is 15½ million barrels daily, in contrast with only 7⅔ million barrels in 1945.

U. S. to Use More. Population of the U. S. will increase more rapidly than in the past. The U. S. Census Bureau has predicted that population of this country will reach 220 million people by 1975, an increase of 55 million during the next 20 years compared with a gain of only 38 million during the preceding 20 years. Present trends make this figure look too low by more than 10 million. This factor alone indicates much higher U. S. oil consumption. In addition, the U. S. will continue to become more highly mechanized and industrialized.

Consequently, U. S. demand for oil is seen as likely to reach 14 million barrels daily by 1975, nearly 6 million barrels greater than the 8¼ million daily which will be consumed during 1955. This estimate may prove to be conservative, as postwar growth has been above this rate of increase. Current consumption is double that of 1943, and two-thirds larger than in 1946.

This is the prospect even though nuclear power will become available shortly, when units like the Duquesne Power Company's project at Pittsburgh goes into operation. Atomic fuels probably will find their greatest use in the electric power generation field, and a goodly portion of all new generating plants may rely on this power. However, it is significant to realize that there will be a tremendous growth in U. S. total energy requirements. It has been predicted that over-all energy needs of the U. S. will increase by two-thirds during the next 20 years. This will provide plenty of room for a fairly rapid rate of growth in the atom's contribution to U. S. energy without disrupting the expansion of other fuels.

Greater Growth Abroad. Consumption of oil will grow at an even faster rate elsewhere in the world. Dramatic possibilities lie ahead.

Demand abroad has more than doubled in the past 10 years. Daily consumption in 1955 has reached 7¼ million barrels, 2½ times greater than the slightly over 2¾ million barrels consumed in 1945. It seems probable that demand outside of the U. S. will

climb to 15 or 16 million barrels daily by 1975.

In the first place, population is increasing faster in the rest of the world. Moreover, many areas abroad are becoming more heavily industrialized, and are turning to mechanized farming and travel at a faster pace than ever before. Large increases in per capita consumption are being experienced.

Western Europe has become a large consumer of oil. Consumption in Western Europe has doubled since World War II, and its present use of slightly less than 2¼ million barrels daily probably will be doubled again during the next 20 years. Thus, by 1975 Europe's consumption will be equal to that of the U. S. 10 years ago.

Even greater possibilities exist in Latin America. Expanding Latin America economy is being based more on petroleum than in any other area. Population now is only a little smaller than in the U. S., and the gap is being closed pretty rapidly. At the same time, per capita consumption is rising sharply. These factors indicate that Latin American countries may be using something like 3¼ million barrels of oil daily by 1975, over twice their present volume of 1¼ million barrels per day.

Canada is another area where a large growth in consumption is anticipated. Current demand of 550,000 barrels per day is nearly three times larger than in 1945, and it is apt to triple again by 1975.

It is much more difficult to foresee the possibilities of the remainder of the world. Although holding 60 percent of the world's population, the Middle East, Far East and Africa use relatively small quantities of petroleum. However, the slightest per capita rise in these areas obviously would result in a substantial increase in oil consumption.

More Production to Be Required. Increased future consumption will require that greater quantities of oil be produced in coming years.

World crude production has doubled in the past 10 years. Current production of 15 million barrels of oil daily compares with a little over 7 million barrels per day in 1945. To keep abreast of rising consumption, future growth in production must be at the same pace. Twenty years from now nearly twice as much oil must be produced.

Much of the gain has come from outside the U. S. during the past decade. While U. S. production has increased by 2 million barrels daily since 1945, output of the rest of the world has risen by 6 million barrels per day. Crude production from outside the U. S. will average 8⅓ million barrels daily in 1955, or 3⅓ times more than in 1945. As a result, production abroad now is nearly 1½ million barrels per day more than in the U. S., although the U. S. was producing twice as much oil as the rest of the world was producing 10 years ago.

The future will see an increasing portion of the world's production come from abroad. We can expect production from outside of the U. S. to more than double its present volume by 1975.

Nevertheless, as there is to be such a tremendous gain in consumption, U. S. production also will have an opportunity to expand in the years ahead. To supply a demand of 14 million barrels daily, the U. S. would need to produce 11¼ million barrels of crude oil and approximately 1 million barrels of natural gasoline per day if imports are limited to 16.6 percent of the nation's crude production. This would be 4½ million barrels per day, or two thirds, more than current U. S. output of 6¾ million barrels, and would constitute a slightly larger rate of growth than experienced during the preceding 20 years.

Even if the U. S. is importing twice as much foreign oil in 1975, the U. S. would need to produce 3¾ million more barrels daily than at present to satisfy consumption requirements. The latter would represent an increase of nearly 200,000 barrels per day per year, just slightly less than the rate of growth experienced during the past decade.

More Wells Must Be Drilled. The fact that far more oil will be needed in the future does not mean that it will be available. Much higher discovery rates must be maintained to provide enough supplies. This will require increased U. S. drilling activity. Despite some surplus producing ability at the moment, it will be necessary to drill more and more wells to provide the far greater volumes that will be needed to satisfy larger future needs.

In drilling enough new wells to keep U. S. producing ability abreast of rising consumption, the industry is faced with the constant necessity of offsetting the inevitable decline of production from the old wells. With the U. S. now operating over half a million producing wells, this has come to represent a sizable operation in itself.

U. S. drilling has undergone an unusually sharp growth in recent years. During the first eight months of this year 35,907 new wells were completed, 1502 more than in the same period of 1954. Consequently, it is expected that 55,000 wells will be drilled in the U. S. this year, 3300 more than last year, almost 12,000 above 1950 rates, and nearly 16,000 over 1948. Footage has increased even more rapidly. During the first eight months of this year 146 million feet were drilled, 6½ million feet above 1954 rates. It is expected that 225 million feet will be drilled in 1955, which would be 75 percent more than the 136 million feet drilled in 1948.

Approximately 6800 wells and about 28 million feet of hole will be drilled in the Free World, exclusive of the U. S., during 1955. This is twice the amount of drilling done in 1950.

Western Canada has become the second most active drilling region in the world during recent years. Almost 2700 new wells and 11⅔ million feet of hole are expected to be completed in Western Canada during 1955. Much of the drilling in Western Canada is done by U. S. contractors. Activity in this area will continue to grow for many years to come.

Competition in Drilling to Continue. While prospects assure further drilling growth, keen competition will continue to exist in the business. Labor, equipment and service costs are apt to be higher tomorrow, while rivalry for contracts will keep revenue down.

Consequently, contractors must seek ways of obtaining still faster penetration rates, less troublesome holes, and of reducing time spent in non-penetrating operations. Only those who keep pace with their most progressive competitors will share in the future's increased drilling volumes.

ACKNOWLEDGMENT

This is an address delivered at the annual meeting of the American Association of Oilwell Drilling Contractors at Houston, September 27, 1955.

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Sen. Robert S. Kerr gives some reasons why . . .

Oil and Politics Must Mix

Progress in the petroleum industry will be determined in part by politics and politicians.

Significant legislative matters include—taxation, federal regulation, petroleum imports, farm policy, conservation, and highway construction.

By SEN. ROBERT S. KERR, Washington, D. C.

THERE ARE THOSE who say that oil and politics don't mix, and there have been times when they haven't. It may be that politicians can survive and prosper free from any connection with oil men, but the survival and progress of the oil business is going to be in part determined, and in the very near future, by "politics, and politicians."

There are six areas of politics, either state or national, or both, which now vitally affect the oil and gas industry, and which will be of even greater significance in the future. They are:

1. The field of taxation.
2. The field of regulation and control.
3. The field of foreign relations as it affects and controls the importation of crude oil and its products.
4. The nation's farm policy.
5. The development and conservation of our natural resources.
6. Expenditure of public funds for highway construction.

Taxation. There are many crusaders and zealots in this country, who, if permitted, would make the national tax laws punitive measures against the oil industry rather than have the industry pay its fair and equitable share of the revenues required by the national government.

Oil and gas are among the dozens of minerals with reference to which the tax laws recognize the necessity and justice of percentage depletion factors. This must be continued in the interest of both prosperity and national security.

Next to planes, and tanks, ships and guns; and, food, feed and fiber, oil has been the most important product in building the military strength by which this country emerged victorious from two World Wars. The genius of our engineers, the skill and patriotism of our aviators, *and* the priceless contribution of abundant motor fuel derived from oil, were the determining factors in making this possible.

Our best military minds tell us we are ahead of Russia now in the production of atomic and hydrogen bombs, but both would be practically useless without the superior supplies of aviation and jet fuels with which the American oil industry continues to supply the air forces of freedom.

Russia certainly has far more oil and gas resources than the U. S. The largest single reason for her comparative low production is lack of profit incentive, by reason of which there has never been and can never be a great Russian oil industry. Without the depletion factor in our revenue laws applying to oil and gas production, we would soon lose this decided advantage. Whether we keep the depletion factor, and how long we keep it, is determined by "politics and politicians."

There are many other features in our tax laws vital to the welfare of the oil industry. Justice and equity demand they be retained, but politics and politicians will also decide that.

Regulation and Control. If the American oil industry is to continue to make its great contribution to the nation's economy and the nation's security, it must be free of federal control. Nothing could stifle it quicker than for the cold, dead hand of federal regulatory control to be clamped on the valves and price of the individual gas wells and the independent gas producers of the nation.

The House of Representatives in 1955 passed the so-called Harris bill. It would restore the exemption of the production and gathering of natural gas from regulation and price control by the Federal Power Commission. This had always prevailed prior to the abortive decision in 1954 of the U. S. Supreme Court in the Phillips case. It is hoped that the Senate, early in the 1956 legislative session, will also pass the Harris bill.

It is just as necessary for the nation's gas consumers as for the nation's gas producers. The Congress passed the Kerr bill in 1950. It was predicted then that if that bill became the law it would mean more gas at less cost to the nation's consumers. It was predicted that if it did not become the law the price would be higher and there would be more consumers who couldn't get the gas they wanted. It was vetoed, and thereby didn't become the law, and the prediction has been fully justified by the record of subsequent events. In the very city where the Congress sat and passed that bill—in the nation's capital where it was vetoed—twice since that date has the price of natural gas to the consumer been raised, and today there are communities in that area asking for gas they cannot get.

The only way that producers can find the necessary additional gas re-

serves to meet the increasing demands is to be free, not only to find it and produce it, but also to sell it in interstate commerce without being forced into the status of a regulated utility. The only way the nation's consumers can hope to have the increasing supplies of gas they need at reasonable prices is for the producers to be free to find it, produce it, and sell it to them.

Farm Policy. The nation's farm policy directly affects the nation's oil industry. Farm policies—contrary to the views of a few misguided individuals—are not fixed on the farm. Farm policies are fixed by the administration in power, by its Department of Agriculture and by the Congress—right square in the big middle of politics.

Nothing could be more true than the statement that "the nation's economy in the long run must reflect the health and vitality of our agricultural economy." This is especially true of the oil industry.

For several years, up to and including 1952, the nation's farmers bought and consumed approximately one-sixth of the refined products annually produced in our country. But the amount farmers have consumed has decreased proportionately in 1953, '54 and '55.

The following pertinent farm facts are of prime interest and importance to the oil industry.

There are nearly 5 million tractors now being used by American farmers, to say nothing of the millions of trucks and automobiles they drive, the millions of passenger miles they ride on the buses, and the thousands of airplanes they fly.

The automotive units on the highways, including passenger cars, buses, and trucks, increased from less than 45 million at the end of 1949 to nearly 59 million at the end of 1954. It is estimated that their number will exceed 63 million by the end of 1955. The number driven or made possible by farm families will be in direct relation to their economic welfare.

Therefore, the oil industry has a deep and continuing interest in a farm program that will insure the nation's farmers an equitable share of the nation's increasing income.

Development and Conservation of Natural Resources. It has been said that the most important raw material required by agriculture and industry today is water. The President's Material Policy Commission recently predicted that "the nation's production of goods and services will double during the present quarter of a century, increasing from $286 billion in 1950 to $572 billion in 1975." This can happen only by and through a more vigorous program of soil and water conservation.

Since it is unquestionably true that what is good for the country is good for the oil industry, every oil man and organization is vitally concerned in the conservation of soil and water, to the extent that proportionate prosperity and industrial growth and development can keep pace with the increase in population and human needs, which are now taking place in such a dynamic manner.

Political developments and decisions will determine to what degree our requirements in these fields are met or denied.

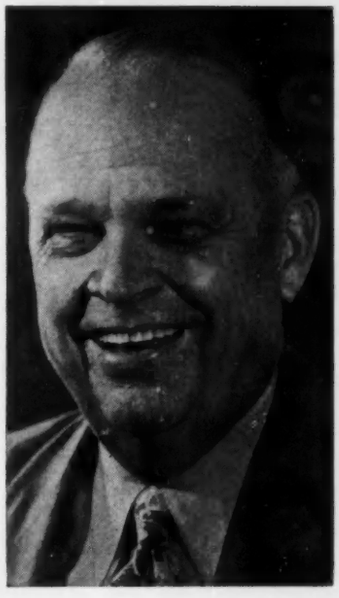
Funds for Highway Construction. And last, likewise, politics will determine whether or not the nation's highway requirements are sufficiently met; or whether we will continue to permit ourselves to have inadequate highways, while the number of automotive vehicles continues to grow at the present amazing rate.

The President's Committee on Roads and Highway Needs, headed by Gen. Lucius Clay, submitted an authenticated report on the nation's needs a few months ago. They told the President and the nation that $100 billion worth of new construction is the minimum required to meet the highway needs of the immediate future.

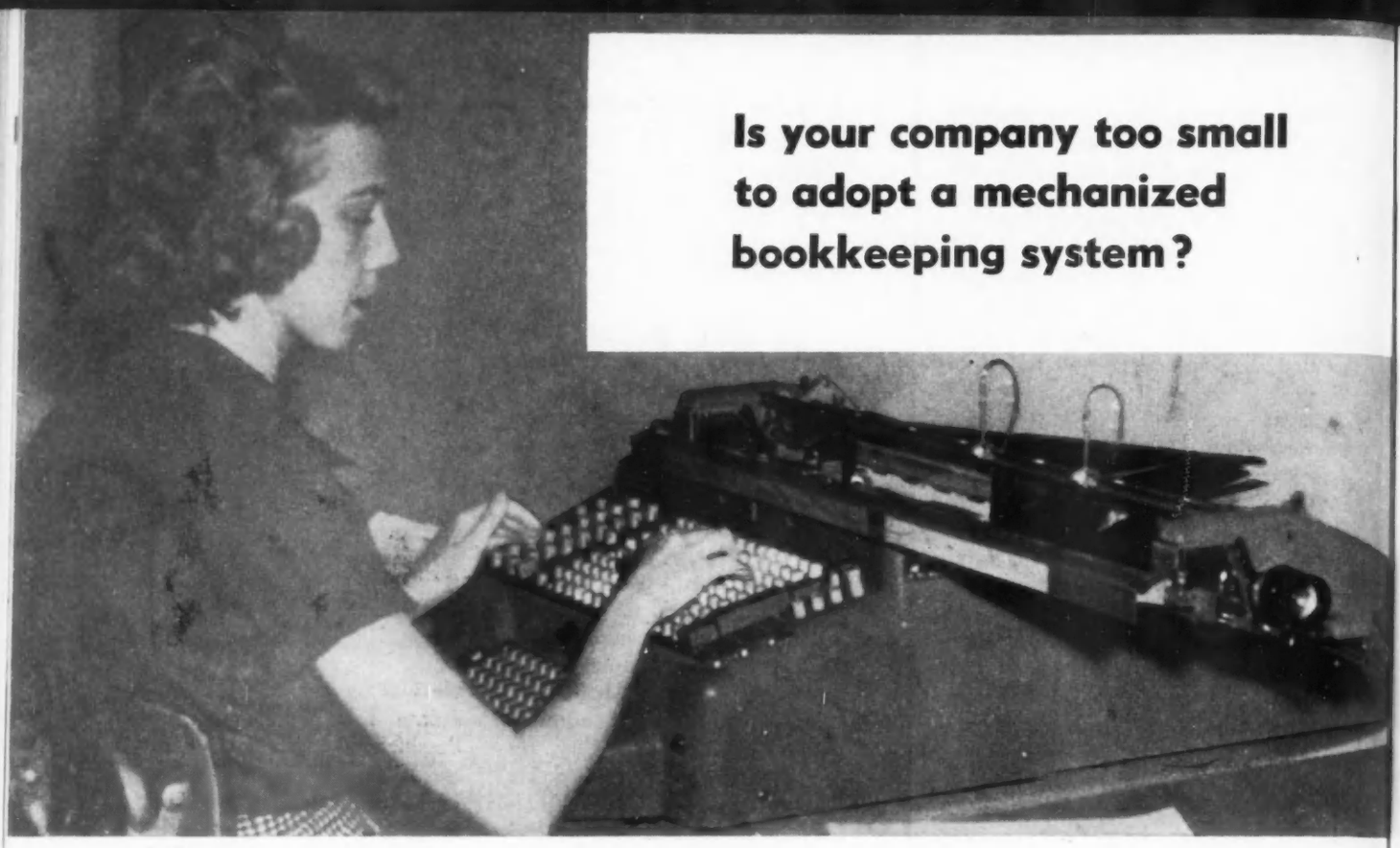
One of the livest questions before the 1956 Congress will be highway legislation. The Senate passed a bill this year that would provide an increased federal participation of $2¼ billion per year. That is the minimum additional which the federal government should provide, not only for the next five years, but for the next 10 years, if an adequate highway program is to be developed. And this program, so vital to the country, and so important to the oil industry, and the question of who pays the bill, will also be determined by "politics and politicians."

Thus, regardless of whether there is any oil in the future of politics, there sure will be a lot of politics in the future of oil. —**The End**

About the Author



SEN. ROBERT S. KERR of Oklahoma was born in a log cabin near Ada, in Indian Territory, now Oklahoma. He attended Oklahoma Baptist University, East Central Teachers College and the University of Oklahoma. After World War I, in which he served overseas as an artillery officer, he returned to Ada to start a produce business. A few years later he entered the drilling contracting business, first as a sideline to the practice of law, and then as a full-time occupation. Since then he has built up one of the strongest independent oil companies in the country—as Kerr-McGee Oil Industries, Inc., headquartered in Oklahoma City. He is chairman of the board. He served as governor of Oklahoma from 1942-46. In 1944 he delivered the keynote address of the Democratic National Convention in Chicago. He was an unsuccessful candidate for the Democratic Presidential nomination at the 1952 national convention. He was elected to his first term in the U. S. Senate in 1948 and reelected in 1954 for the term ending January 3, 1961.



Is your company too small to adopt a mechanized bookkeeping system?

Here's how one average-sized firm saved $9000 a year and discovered that . . .

Machine Accounting Can Cut Costs

Records are more accurate, legible, and up-to-date. Fewer employes are required.

By H. C. MARTIN, Treasurer,
and L. K. NEWTON, Assistant Secretary,
Wrather Petroleum Corporation, Dallas

WHY ARE YOUR bookkeeping records still kept under pen-and-ink methods—or at best on a part machine, part hand basis?

If this question were asked of 100 average-sized oil companies, probably 90 would reply, "We are too small to think of fully mechanizing our bookkeeping work!"

It is the most natural thing in the world to have this attitude, especially in view of the fact that some of the machine accounting methods used by very large oil companies are, indeed, far too costly for the small or medium-sized firm.

The purpose of this article will be to show how full bookkeeping mechanization can be attained on *a single accounting machine,* at considerably *less cost* than the most economical pen-and-ink system ever devised.

One typewriter-bookkeeping machine handles all major bookkeeping requirements for our company. Not only are records far more accurate, legible and up-to-date, but the job is accomplished with three less people than needed under hand methods. Just why this is so can perhaps best be brought out by outlining here some of the actual bookkeeping machine operations. A mental comparison can then be made with the number of separate operations required to complete the same work using pen-and-ink records.

Accounts Payable—Joint Interest Billing. The accounts payable function is illustrated in Figure 1. You will observe immediately that *all* re-

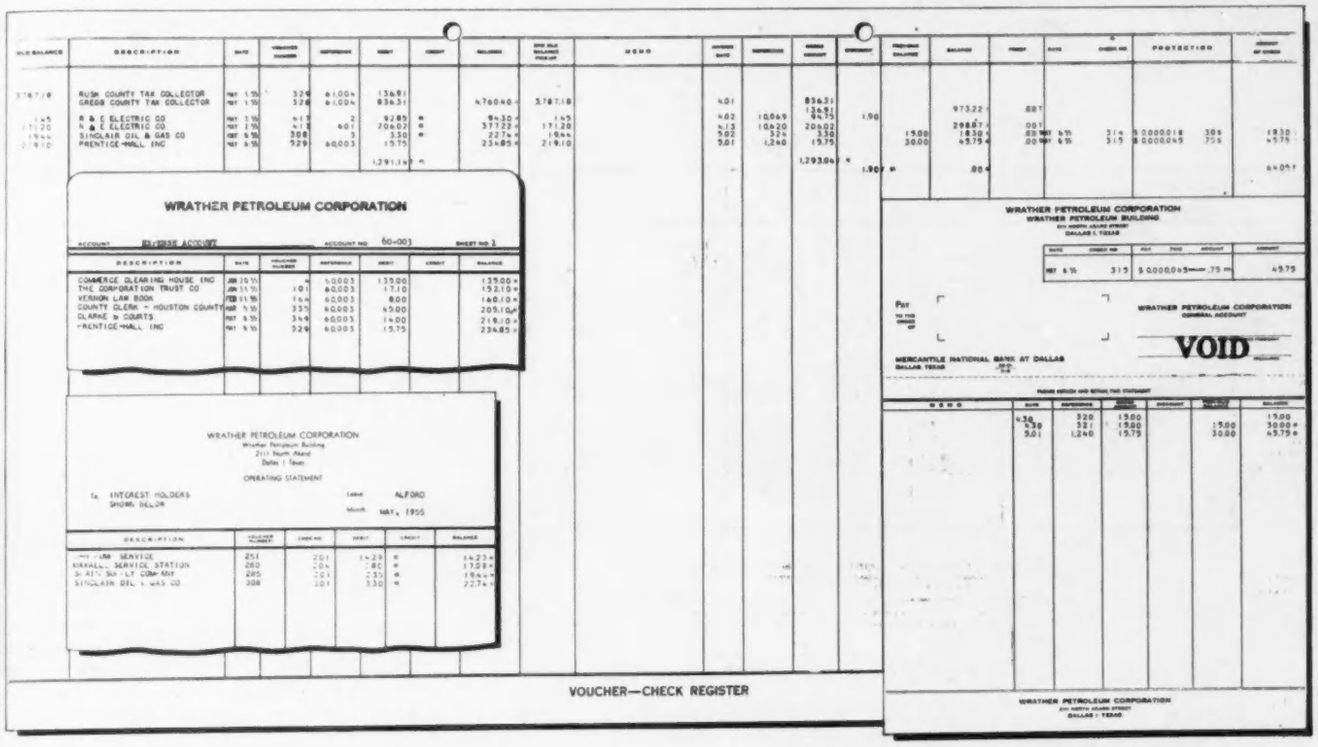


FIGURE 1—Accounts Payable and Joint Interest Billing. Vendors' invoices are vouchered in the center section, and the check then written at the right. At the left, amounts are distributed either to expense accounts (top), or directly to an operating statement for joint interest accounts.

lated records may be prepared by machine at the same time—the distribution of the amount directly to the affected general ledger card, the remittance advice to the vendor, the voucher (duplicate of remittance advice), the check, and the voucher-check register itself.

The operator of the machine, posting directly from vendor's invoices—which have been coded as to distribution—inserts the proper general ledger card, "picks up" the old balance and makes the entry, the machine automatically computing and printing the new balance. A similar posting is made to the voucher-remittance advice, which is then either placed aside for filing, or, if a check is to be issued immediately, is "moved over" to the check register portion of the voucher-check register, where the check is written. Notice that there is an automatic ".00" proof that balances were picked up correctly and that the amount distributed was exactly the same as the gross amount entered on the remittance advice.

If there are several invoices from the same vendor, normally they will affect the same general ledger distribution card; but if two or more cards are affected, they are simply posted, one at a time, before the voucher-remittance advice is written. The machine still proves that the total distributed was equal to the total entered on the voucher-remittance advice.

As postings are made, the journal columns for debits, gross amount, discount and net check automatically accumulate. The debits must of course equal the gross amount, and the net posting must be the same as an add-list of the invoices, run beforehand.

Joint Interest Accounts. As shown in Figure 1, when the purchase affects a joint interest account, an operating statement is inserted in the machine instead of a general ledger card. Beneath this operating statement is a "Ditto" Master. At the end of the month, all we have to do is run off the required number of copies of each operating statement on the Ditto machine, instead of re-copying all this information. Ditto copies are sent to each joint interest holder, in support of his share of expenses. We have 90 leases, of which 50 are joint interest operating leases involving billing to joint interest owners.

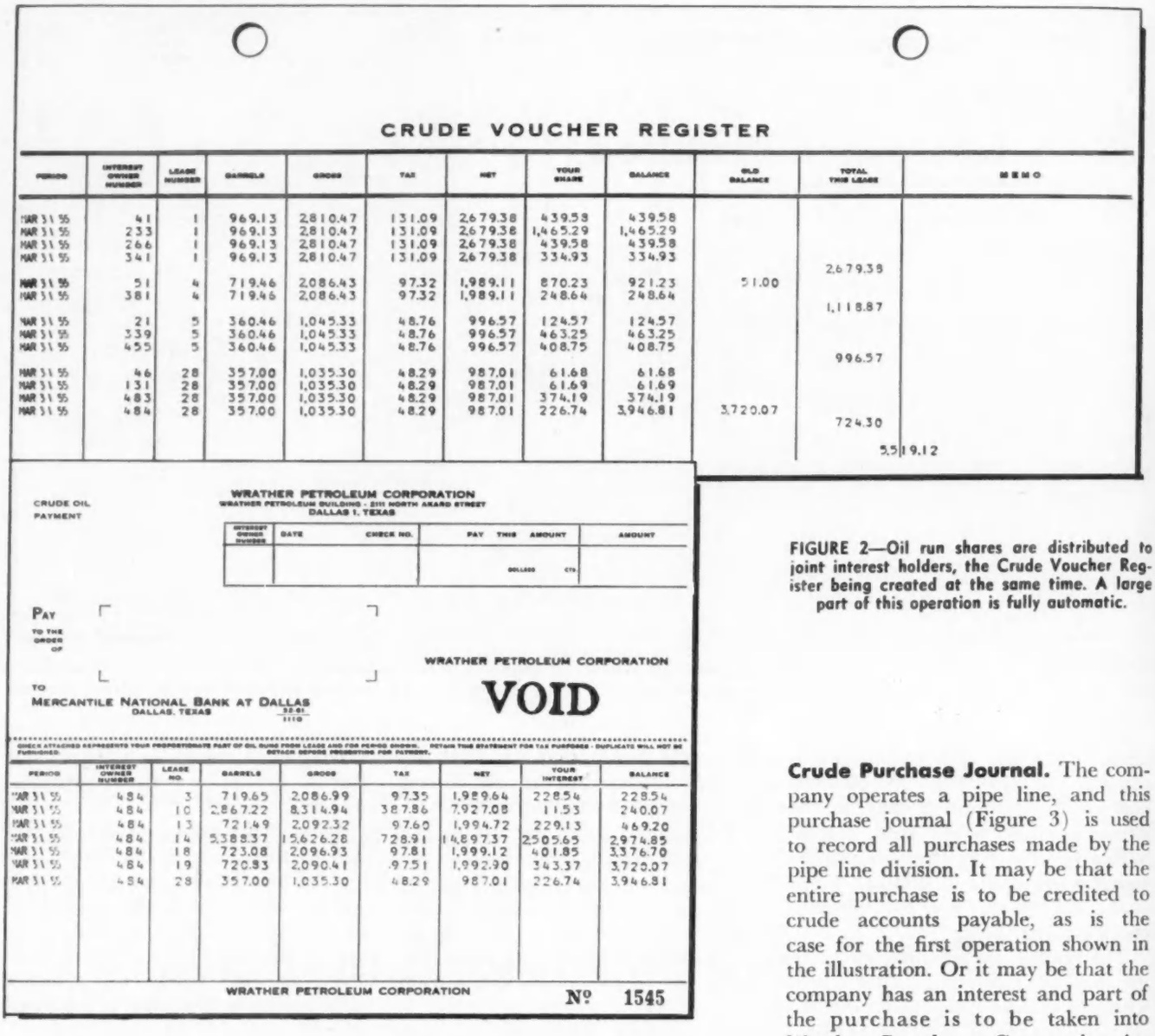
"Dual" Nature of Accounts Payable Operation. Note that with this kind of accounts payable operation, the entire job may be done at once, including the writing of a check—or a voucher may be written without making out a check—or a check alone (for a previously written voucher) may be prepared.

Most of the time the voucher portion of the check is "built up" during the month, and then the check is written separately on the check register journal. But there are times when we do want to issue a check immediately, and the system was designed with complete flexibility to take care of such contingencies.

The number of invoices averages 600 a month, with approximately 900 distribution postings. That is, there is an average of 1.5 distributions per invoice.

Crude Voucher Register. Mechanization of the Crude Voucher Register (distribution of oil run shares to joint interest holders) saved $40 a month in stationery and postage alone. Formerly one check was written for each interest owner for each lease; in other words, if one person had an interest in 20 leases he would receive 20 checks. With the machine operation, the same person receives one check, with 20 entries on the voucher portion.

The forms are shown in Figure 2. For any one lease, the lease number, number of barrels, gross amount, tax and net amount will be the same;



CRUDE VOUCHER REGISTER

PERIOD	INTEREST OWNER NUMBER	LEASE NUMBER	BARRELS	GROSS	TAX	NET	YOUR SHARE	BALANCE	OLD BALANCE	TOTAL THIS LEASE	MEMO
MAR 31 55	41	1	969.13	2810.47	131.09	2679.38	439.58	439.58			
MAR 31 55	233	1	969.13	2810.47	131.09	2679.38	1,465.29	1,465.29			
MAR 31 55	266	1	969.13	2810.47	131.09	2679.38	439.58	439.58			
MAR 31 55	341	1	969.13	2810.47	131.09	2679.38	334.93	334.93			
										2679.38	
MAR 31 55	51	4	719.46	2086.43	97.32	1,989.11	870.23	921.23	51.00		
MAR 31 55	381	4	719.46	2086.43	97.32	1,989.11	248.64	248.64			
										1,118.87	
MAR 31 55	21	5	360.46	1,045.33	48.76	996.57	124.57	124.57			
MAR 31 55	339	5	360.46	1,045.33	48.76	996.57	463.25	463.25			
MAR 31 55	455	5	360.46	1,045.33	48.76	996.57	408.75	408.75			
										996.57	
MAR 31 55	46	28	357.00	1,035.30	48.29	987.01	61.68	61.68			
MAR 31 55	131	28	357.00	1,035.30	48.29	987.01	61.69	61.69			
MAR 31 55	483	28	357.00	1,035.30	48.29	987.01	374.19	374.19			
MAR 31 55	484	28	357.00	1,035.30	48.29	987.01	226.74	3,946.81	3,720.07		
										724.30	
										5,519.12	

CRUDE OIL PAYMENT

WRATHER PETROLEUM CORPORATION
WRATHER PETROLEUM BUILDING - 2311 NORTH AKARD STREET
DALLAS 1, TEXAS

INTEREST OWNER NUMBER	DATE	CHECK NO.	PAY THIS AMOUNT DOLLARS	CTS.	AMOUNT

PAY TO THE ORDER OF

TO MERCANTILE NATIONAL BANK AT DALLAS
DALLAS, TEXAS 32-61 1110

WRATHER PETROLEUM CORPORATION

VOID

CHECK ATTACHED REPRESENTS YOUR PROPORTIONATE PART OF OIL RUNS FROM LEASE AND FOR PERIOD SHOWN. RETAIN THIS STATEMENT FOR TAX PURPOSES - DUPLICATE WILL NOT BE FURNISHED. DETACH BEFORE PRESENTING FOR PAYMENT.

PERIOD	INTEREST OWNER NUMBER	LEASE NO.	BARRELS	GROSS	TAX	NET	YOUR INTEREST	BALANCE
MAR 31 55	484	3	719.65	2,086.99	97.35	1,989.64	228.54	228.54
MAR 31 55	484	10	2867.22	8,314.94	387.86	7,927.08	11.53	240.07
MAR 31 55	484	13	721.49	2,092.32	97.60	1,994.72	229.13	469.20
MAR 31 55	484	14	5,388.37	15,626.28	728.91	14,897.37	2505.65	2,974.85
MAR 31 55	484	18	723.08	2,096.93	97.81	1,999.12	401.85	3,376.70
MAR 31 55	484	19	720.83	2,090.41	97.51	1,992.90	343.37	3,720.07
MAR 31 55	484	28	357.00	1,035.30	48.29	987.01	226.74	3,946.81

WRATHER PETROLEUM CORPORATION

Nº 1545

FIGURE 2—Oil run shares are distributed to joint interest holders, the Crude Voucher Register being created at the same time. A large part of this operation is fully automatic.

therefore these figures are entered in the machine *only once* for each lease. The machine "remembers" these amounts. After making these entries one time, the machine operator inserts the voucher for the first joint interest holder. All she need do is pick up the old balance, if any, on that voucher, and insert the interest owner number. The machine prints the date, lease number, barrels, gross, tax and net, automatically and in rapid succession. Operator enters "your interest" and the balance prints automatically.

When all vouchers have been posted for that lease, the machine is allowed to clear out the repeating figures automatically (without printing them). The total for this lease is cleared and printed on the voucher register, and should agree with the net amount being distributed, if the entire distribution has been made.

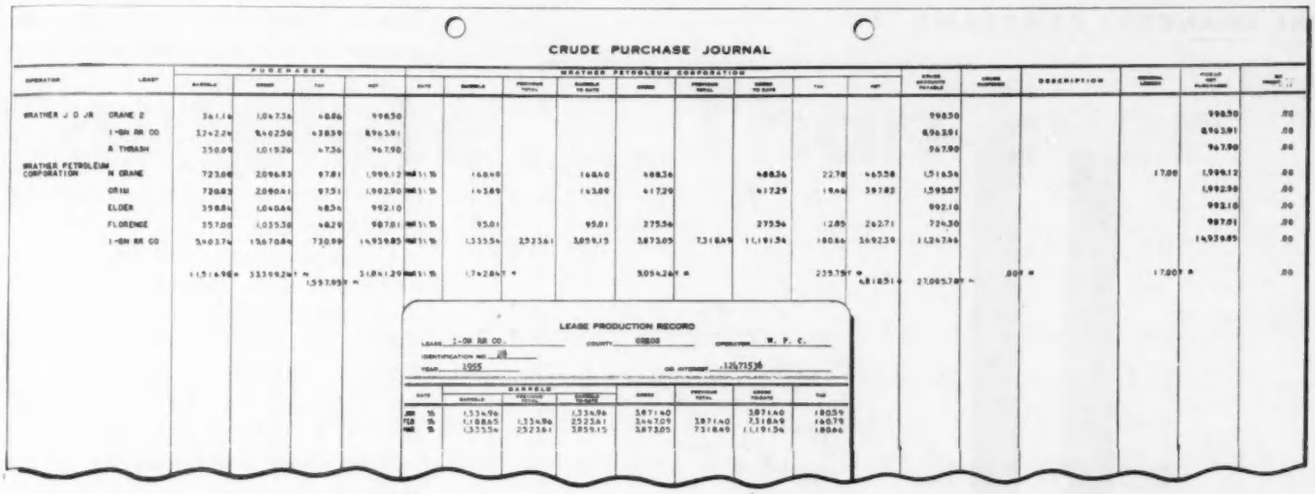
After shares for all leases have been distributed, the grand total is cleared from the machine, as shown in the illustration. Volume on this job is about 800 "lines" a month on the crude voucher register.

Crude Check Register. Checks for oil interests (upper portion of crude voucher) are also written by machine. The forms are not shown for reasons of space, but the procedure is similar to the checkwriting operation shown in Figure 1. Checks are dated, numbered and protected automatically, a check register being created at the same time. About 500 checks are written each month.

Crude Purchase Journal. The company operates a pipe line, and this purchase journal (Figure 3) is used to record all purchases made by the pipe line division. It may be that the entire purchase is to be credited to crude accounts payable, as is the case for the first operation shown in the illustration. Or it may be that the company has an interest and part of the purchase is to be taken into Wrather Petroleum Corporation income. In the latter instance, a Lease Production Record is inserted in the machine as posting is made. The number of barrels, gross amount and figures are entered on this ledger card and print through to the journal. In addition, the machine (a National "Class 31") automatically prints the "barrels to date" and "gross to date" figures. Thus we have a detailed income ledger, by leases, with totals that are continuously up-to-date and in proof.

The Crude Suspense column is used, as in hand bookkeeping, for amounts to be paid out in the future, but which are delayed for one reason or another. The volume of posting on this application is approximately 100 lines a month.

Payroll. A bi-weekly payroll for 25



CRUDE PURCHASE JOURNAL

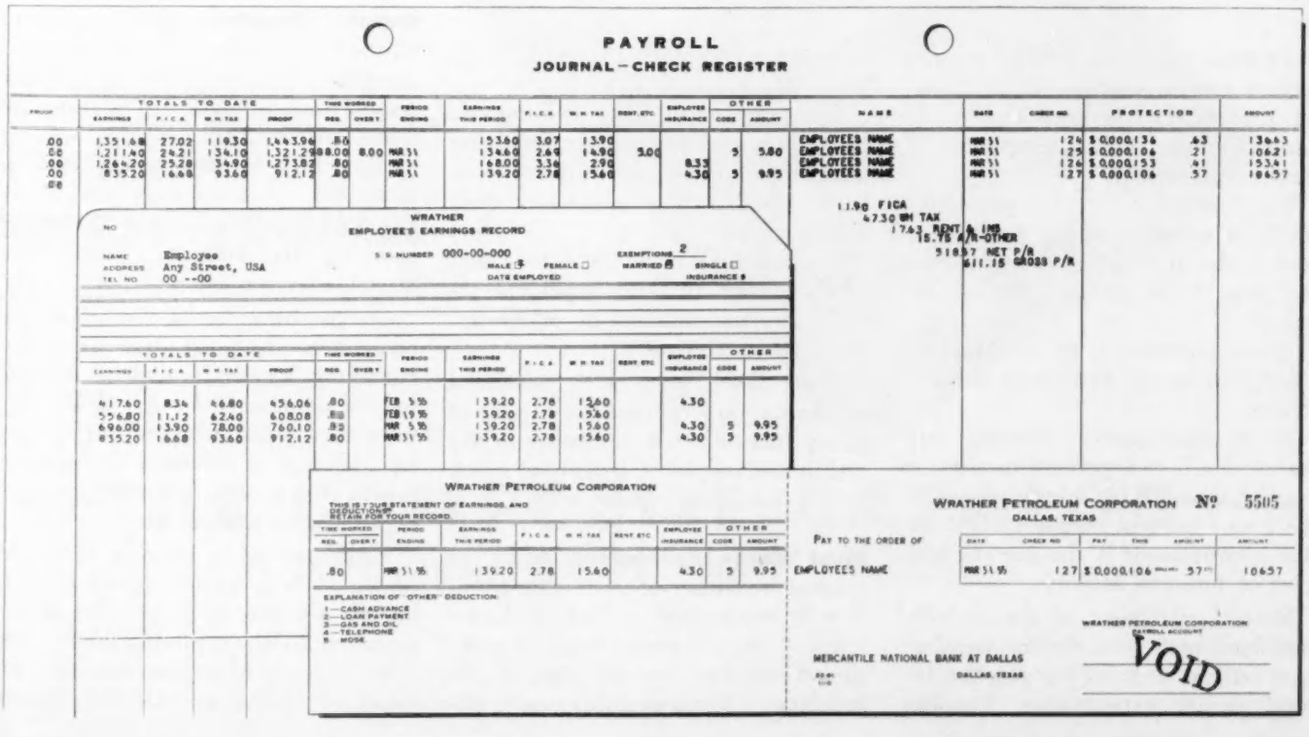
LEASE PRODUCTION RECORD

FIGURE 3—Purchase journal used to record all purchases made by the pipe line division. Note automatic computation of barrels to date and amount to date for each lease.

employes is also written on the same accounting machine; forms are shown in Figure 4. All payroll records—employe's pay statement, earnings record, check, payroll journal and check register—are made at the same time. Journal columns accumulate in separate totals as posting occurs. Observe that totals to date for earnings, F.I.C.A. and withholding tax are automatically figured and printed on each employee's earnings record. This greatly facilitates preparation of quarterly and year-end payroll reports, which are also done by machine.

Advantages of Machine Operation. The primary benefit of machine accounting is, needless to say, the financial advantage. At the most conservative estimate, the company is saving over $9000 a year as compared to the old pen-and-ink system. But this is not the only consideration. Records are far more accurate and up-to-date now than they could be, as a practical matter, under any hand-written bookkeeping method. Information needed is available when wanted. And the system is the same no matter who runs the machine; it is not subject to the whims of any individual. There is no "training" problem; the equipment is easier to operate than a set of hand records.

The company could not afford to have a vast array of expensive accounting equipment, any more than other medium-sized companies. But we found that we cannot afford to be *without* a flexible, low-cost system—a "one machine" system that provides mechanization of all our accounting records. **—The End**

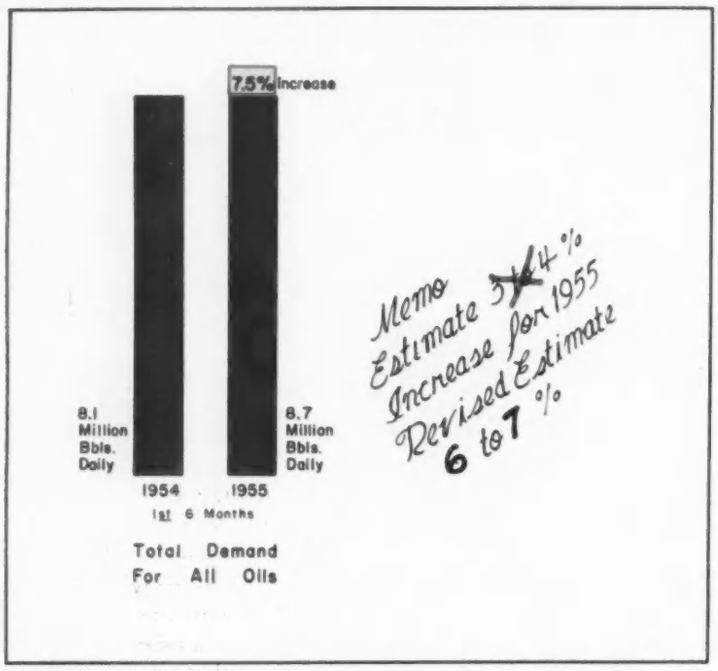


PAYROLL
JOURNAL—CHECK REGISTER

WRATHER
EMPLOYEE'S EARNINGS RECORD

WRATHER PETROLEUM CORPORATION

FIGURE 4—Payroll is another machine "extra." Earnings record, pay statement, check, check register and payroll journal are all printed at the same time. Earnings, F.I.C.A. and Withholding Tax to date are automatically printed on each employee's earnings record.


7.5% Increase
8.1 Million Bbls. Daily
8.7 Million Bbls. Daily
1954
1955
1st 6 Months
Total Demand For All Oils
Memo Estimate 3 1/4 % Increase for 1955 Revised Estimate 6 to 7 %

1955 . . . *a good year for oil*

Operating results are satisfactory. Demand for petroleum products up sharply. Supply fairly well balanced with demand. Further vigorous growth is indicated.

INTERIM RESULTS indicate a satisfactory current year for the oil industry, reports The Northern Trust Company, Chicago, in a recent issue of *Business Comment*.

Total demand for all petroleum products increased more than 7 percent in the first half of this year over the like 1954 period, the review stated.

Other comments by the financial institution on the petroleum industry follow:

As a consequence, original estimates of a 3 to 4 percent increase in over-all demand have been revised to the 6 to 7 percent range. Underlying this improvement is the present high level of business activity.

Record purchases of automobiles, combined with good driving weather, have pushed demand for gasoline beyond earlier expectations. Gasoline production has been at record high levels this summer.

Consumption of home heating oils has improved over last year, reflecting the more rigorous past winter as contrasted with the unseasonably mild 1953-54 winter.

In addition, it is expected that there will be an 8 to 9 percent increase in the number of oil burner installations this year.

More diesel fuel is being consumed by the nation's railroads, and sales of heavy fuel oil, used in electric utility and industrial plants, have been much larger than anticipated earlier.

Must Watch Inventories. While the current inventory of petroleum products is reasonably in line with demand, the situation requires continued vigilance on the part of the industry to avoid demand-supply imbalance. Latest figures reveal that the price structure in refined oil markets is generally strong.

Refinery runs continue at a high rate substantially in excess of the 1954 pace, but heavy demand has offset this sharp increase in refinery operations.

Gasoline inventories are slightly under last year, though it should be noted that stocks of gasoline were at rather high levels through mid-1954. Distillate fuel oil stocks surpass last year's supply by a wide margin at this time.

Proration of production in the major U. S. producing areas of Texas, Louisiana and Oklahoma has been the major factor keeping supply in line with demand at steady prices as conditions change.

Texas wells were permitted to produce 236 days in 1953, but were reduced to 194 producing days in 1954, bringing about an average production allowable cut of four percent.

The price structure should be high enough to encourage exploration and development of new proven reserves, which is an expensive operation at present costs for drilling deeper wells now necessary in most areas.

The fact that through extensive drilling operations the industry has been able to find new reserves to match heavy use is perhaps the best indication of a reasonable price level for crude.

Imports Situation. The volume of oil imports into the U. S. has received increasing attention and is a major reason for the restriction of domestic crude output. Imports have been at all-time high levels recently, and independent domestic producers have urged statutory limitations on imports claiming that voluntary curbs have been ineffective.

On the other hand, the importing companies contend that legislation curtailing imports would be adverse to the national interest, which dictates that conservation of our domestic resources is necessary for possible future emergencies when foreign supply would be unavailable.

Estimates place imports of crude oil for 1955 at an average of 742,000 barrels per day, or 11 percent of anticipated domestic production for this year. Imports of refined products are expected to average 451,000 barrels

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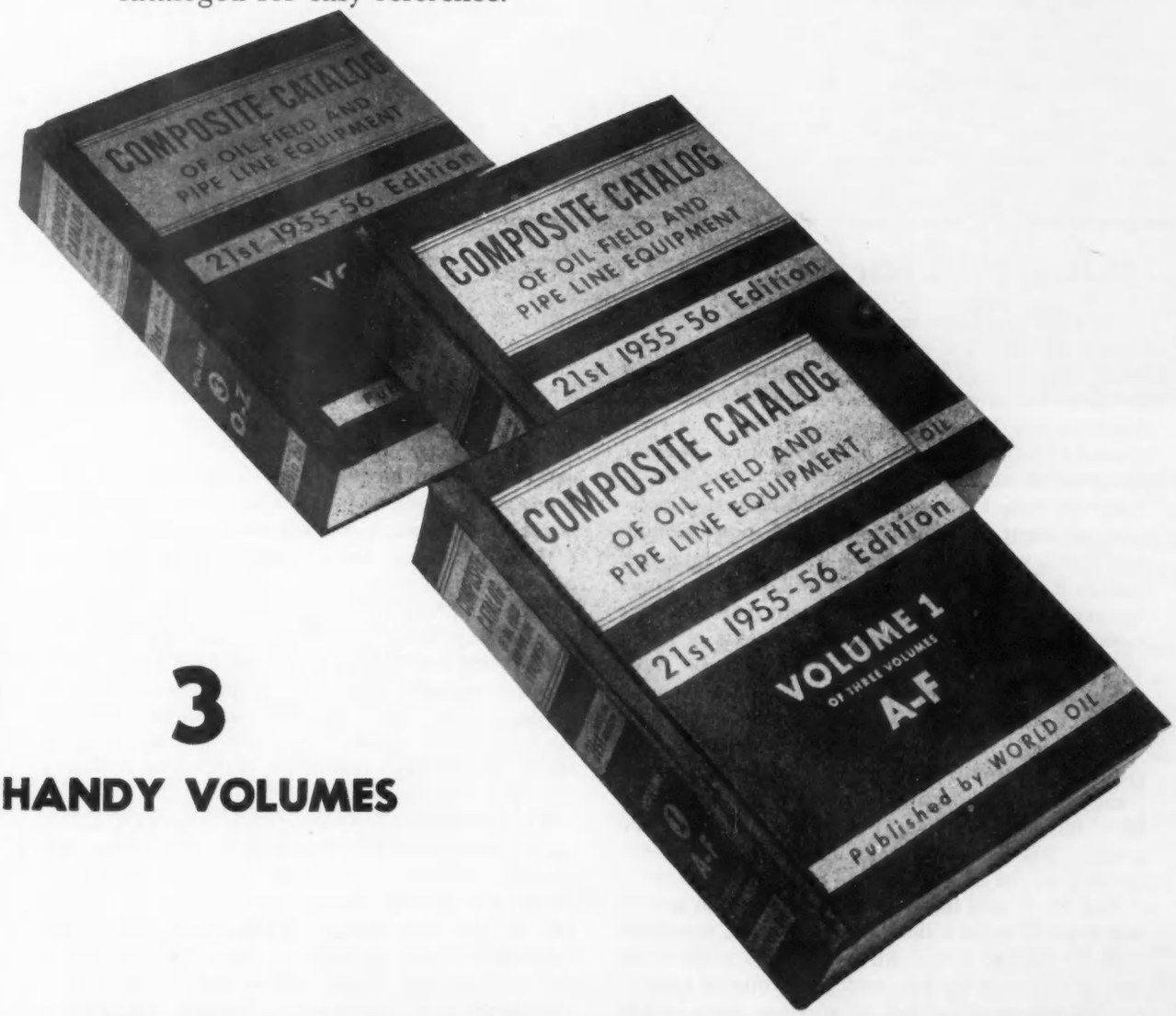

3

HANDY VOLUMES

THE COMPOSITE CATALOG

PUBLISHED BY WORLD OIL

per day, or 6.7 percent of domestic crude production.

The percentage of imports to domestic production for this year is expected to be slightly in excess of the figure recommended by the President's cabinet fuels policy committee, and the defense mobilizer chairman of the committee now has the situation under consideration.

Many observers believe that the problem will be alleviated as world consumption cotinues to expand, since foreign production will find outlets to an increasing extent in European and other overseas markets.

The present geography of world oil is interesting as a background for an understanding of the import situation. World production of crude has about doubled since World War II, while U. S. production during this time has risen only 35 percent.

Output in this country has steadily declined as a proportion of the free world total, from 70 percent in 1946 to an estimated 50 percent this year.

Petroleum Reserves. The status of petroleum reserves also indicates the significance of foreign holdings. Middle Eastern reserves were 60 percent of the world total at the end of 1954, while U. S. reserves totaled 19 percent.

It has become increasingly costly and more difficult to locate and develop new reserves in this country. Dry holes averaged 37 percent of total wells drilled in the U. S. during 1954, compared with an average of only 22 percent in the five years prior to World War II.

However, domestic reserves appear adequate, because proven discoveries have exceeded production, so that proven reserves continue to aggregate 13 to 14 times a year's production at current rates.

The petroleum industry gives every promise of continuing its long-term growth pattern. Demand for petroleum products in the United States alone has increased at an annual average rate of 5.6 percent since 1919, and total world production and consumption of petroleum have doubled in the last 10 years.

With the increased industrialization and rising standards of living in most areas of the world, it is highly probable that total global demand for petroleum products will continue to expand rapidly.

Moreover, managements of petroleum companies have wisely improved their basic position by spending large sums for research calculated to improve production and refinery processes. **—The End**

Industry leaders take a look at 1975 . . .

OVER 25 BUSINESS LEADERS recently attempted to foresee and describe the U. S. of 1975, or 20 years hence. Their prophecies will be sealed for 20 years in the cornerstone of a new office building of Fundamental Investors, Inc., and three other mutual funds at Elizabeth, N. J. Following are some of the forecasts:

By 1975 the U. S. will have 213 million population, or about 60 million more than now, gaining 3 million a year. There will be 85 million employed, against 65 million now. People will work six hours less per week and be paid 25 percent more for their work. The nation will enjoy the benefits of many technological advancements. There will be more production, more material things, more leisure, more retired people, and more schooling.

Scientific developments have opened tremendous vistas of material progress. This age of atomic energy, aviation, electronics, new metallurgy, chemistry, and new technology, has jet-propelled us into a chain reaction of progress. The economy of the country should at least double in the next 20 years.

The U. S. will have 92 million television sets. It will have 80 to 84 million passenger cars, compared with 50 million now, with well over 8 million new cars per year being sold and a majority of families owning two or more cars. In addition, there will be in use 18 million trucks and busses.

Petroleum consumption will exceed 13 million barrels daily, against over 8 million currently. The oil industry will supply much more synthetic rubber, chemicals, and fertilizers.

T. S. Petersen, president of Standard Oil Company of California, predicted that: "Providing additional productive resources to support 60 million more people will challenge our enterprise, especially if we expect everyone's standard of living to continue to increase at the rate of the last generation.

"The petroleum industry will face heavy demands to meet this rapidly growing market. By 1975 the energy requirements of the U. S. may exceed the equivalent of over 36 million barrels of crude oil per day, approximately twice the present needs. Our domestic crude production may furnish a third or more of these requirements. New forms of energy may have reached the stage where they will be supplementing fossil fuels to a sizable degree in supplying our total energy requirements. The petroleum industry will have to carry on a greatly expanded program of capital investment in exploration, producing, refining, transporting, and marketing these products in order to contribute its share to the large and more prosperous economy which we see for 1975."

M. J. Rathbone, president of Standard Oil Company (New Jersey), forecast that: "Atomic energy should be meeting a share of our energy needs (by 1975), but the share seems likely to remain a minor one in our total energy picture. Coal use should have leveled off, probably at about 500 million to 600 million tons. Hydroelectric power should have expanded very moderately. Natural gas should have continued to furnish an important part of our energy supply, but its rate of growth should have been very modest compared with its growth in the years before 1955." The 1975 "energy work-horse," said Rathbone, "promises still to be petroleum. The U. S. should require about 60 percent more than now—in excess of 13 million barrels a day, as compared with more than 8 million barrels today."

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ANTI-POLLUTION LAW:
Threat to Oklahoma Oil Producers

Unless the state and the oil producers can get together on Oklahoma's anti-pollution law, the next six months may find:

- **Thousands of producing oil wells plugged and abandoned.**
- **Income of many producers substantially cut.**
- **Amount of the gross production tax collected by the state reduced drastically.**
- **Production decreased.**
- **Property losses—leases and producing wells—high.**

UNLESS OKLAHOMA regulatory bodies and oil producers can get together on economic, as well as effective methods for disposing of salt water and other oil wastes, thousands of producing wells may be plugged and abandoned within the next six months. Income of hundreds of producers, large and small, will be reduced materially. Property losses to producers from shutting down wells will be tremendous. And the state of Oklahoma stands to suffer a drastic reduction in income from loss of the gross production tax collected on production from these wells.

This situation, according to independents and executives of oil companies operating in Oklahoma, will be adversely reflected throughout the industry in the Mid-Continent area. Oil producers are anxious to cooperate with the various state regulatory bodies entrusted with the problem, but feel that this problem is not presently clearly understood.

The cause of the present serious problem is the anti-pollution law enacted by the Oklahoma legislature and the order of the Oklahoma Corporation Commission establishing rules and regulations to enforce that law and carry out its provisions.

Under the law "pollution of fresh waters by deleterious substances resulting, obtained, or produced in connection with drilling, producing, refining, or processing of oil or gas is prohibited."

The Oklahoma Corporation Commission is charged with enforcement of rules and regulations to prevent pollution of fresh waters, with the assistance and cooperation of the division of water resources of the Oklahoma Planning and Resources Board and the State Game and Fish Department. The state board of health, also, is interested in the subject.

Each of the four organizations named naturally feels responsible, at least in part, for strict enforcement of rules and regulations to prevent pollution.

Disposal Means. All the water produced with oil in Oklahoma is salt water. This salt water is disposed of in a number of ways. One is to pump it down into wells drilled to salt-water bearing formations. Another is to construct large ponds where the water would evaporate. Siphons have been placed in many ponds or pits. These would permit disposal of the salt water into a ditch or creek but would prevent any oil or other substance from leaving the pond or pit.

In many areas, such as in the Greater Seminole area where vast quantities of salt water are produced

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If producers are forced to drill salt water disposal wells and case them, it is estimated that the cost will average $65,000

with the oil, the salt water has been run into old river or creek beds such as Little River and Wewoka Creek. It was stated at a corporation commission hearing that there has been practically no fresh water in either Little River or Wewoka Creek for a long time other than during heavy rains.

Salt water often soaks into the river or creek bed without contaminating grounds on either side of the stream bed.

If crude oil producers are not permitted to dispose of salt water as they have been doing, and the new law says they cannot continue certain past practices, such as installation of siphons and other ways to get rid of salt water but keep oil or other deleterious material from contaminating property, cost of disposing of salt water in many areas will be prohibitive for many producers.

Prohibitive costs of disposing of salt water will force many operators to plug and abandon their wells.

According to an order of the corporation commission, operators are allowed time, not to exceed six months, within which to comply with the rules and regulations. The order was dated September 9 so all producers must comply with its provisions before next March 9.

In the Greater Seminole area, including the producing oil fields of Seminole, Bowlegs, Little River, Earlsboro, St. Louis, Keokuk, East Little River and Maud, wells produce nine barrels of salt water with every barrel of oil. Wells average 12 barrels of oil and 108 barrels of salt water a day. Latest available figures show that 5256 active oil wells produce an average of 61,791 barrels of oil a day. This production is from the First Wilcox sand at about 4200 feet.

With an average of 64 wells to the section, or square mile, production of salt water in the Greater Seminole area would average 7000 barrels a day per square mile. Oil production would average 768 barrels a day per square mile.

$65,000 Per Well. If producers in the Greater Seminole area are forced to dispose of the salt water from their wells by drilling salt water disposal wells, such wells would have to be drilled to the Second Wilcox sand at from 4700 to 5000 feet. To drill a well to a depth of 5000 feet and case it to prevent salt water from contaminating any fresh water horizon, it is estimated the cost would average $65,000. Such a well could take care of about 3000 barrels of salt water a day.

To dispose of 7000 barrels of salt water a day in every square mile of the Greater Seminole area would require at least two salt water disposal wells per square mile, or a cost of $130,000 for the two wells. This would mean that the prorata cost of the salt water disposal wells would be $2031 for each owner of each of the 64 producing oil wells in the square mile.

Tubing, casing and other steel equipment corrode quickly in the presence of salt water, and repairs are costly. So, with high costs of repairs annually, and other operating costs, the average small producer would think a long time before putting up $2030 for each well he owned in order to dispose of the salt water.

It has been estimated it would cost $2 million for salt water disposal wells to care for all the salt water produced by the 574 oil producing wells in the Oklahoma City field.

One engineer who has made a study of the subject, said he figures an average cost of $2500 per well over the state of Oklahoma for subsurface disposal of salt water produced with oil. Obviously, he said, this cost would be higher in some areas and lower in others, depending upon the depth to which salt water disposal wells had to be drilled.

While the Greater Seminole area and Oklahoma City are especially large producers of salt water with the oil, many other oil fields in Oklahoma would have to use salt water disposal wells to solve the problem. There is a lot of salt water produced in Osage County which is particularly active in drilling operations at this time. Shamrock, Drumright and many other fields produce a lot of salt water.

Abandoned Wells. In many fields, abandoned wells might be used as salt water disposal wells by deepening them to a salt water horizon and casing them properly. This would reduce costs very materially for the owner of such wells.

But all leases in an area would have to be unitized for salt water disposal if all producers were to have means of getting rid of salt water and if such means meant drilling of salt water disposal wells or using some old, abandoned wells for disposal purposes. The owner of an abandoned well might want to use it for disposal of his own salt water and might not be able to handle any more than what his own wells were making.

Abandoned wells certainly will be used wherever possible and this will reduce costs of salt water disposal. And lower costs will lessen the number of producing oil wells which will be plugged and abandoned. This will reduce loss of income to producers and to the state.

But, a lot of producing oil wells are going to be plugged and abandoned. Income of a lot of producers is going to be cut substantially as will the gross production tax collected by the state. Production will decrease and property losses—leases and producing wells—will be high.

Revenue from the 5 percent gross production tax levied in Oklahoma on the value of all oil and natural gas produced in the state, is the third highest income received by the state. For the year ended June 30 last, income to Oklahoma from the gross production tax was $28,632,000. From the gasoline and fuel excise tax, revenue totaled $46,742,000, this being the greatest source of revenue for the state. The sales tax brought in $44,415,000 during the year.

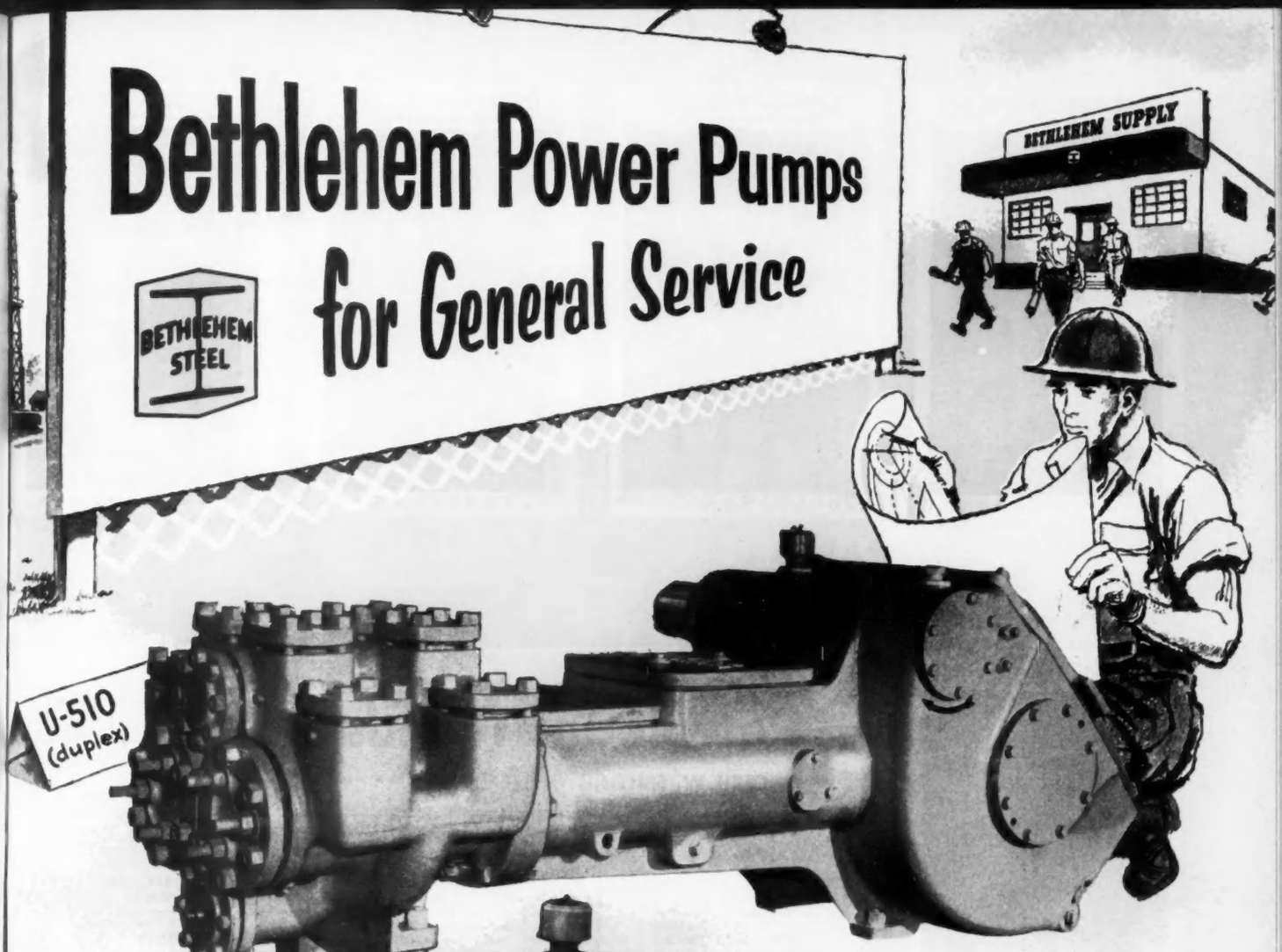
Any reduction of the income from the gross production tax would mean a lot to Oklahoma.

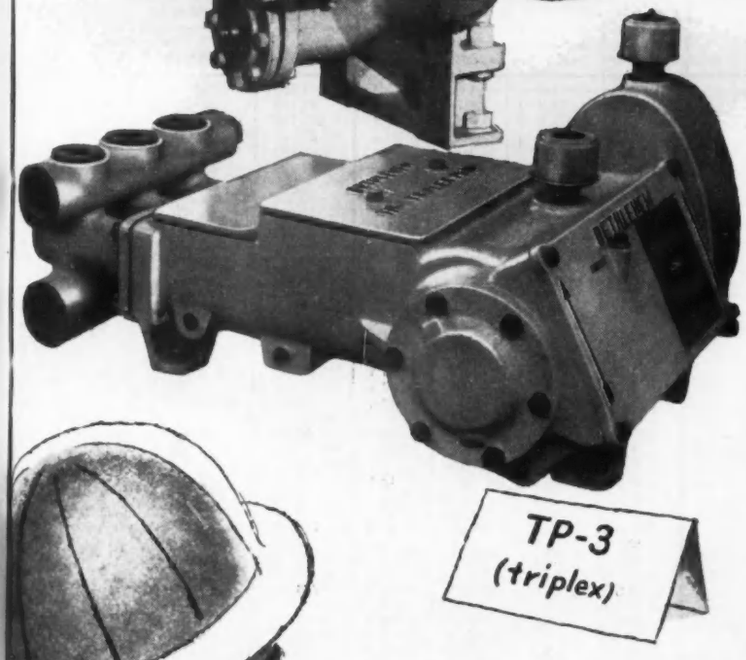
An engineer for a major oil company operating in Oklahoma, said he figured his company might have to shut down 30 percent of its producing wells in areas which produced a lot of salt water with the oil.

"That estimate may be a little high, or it might be too low," he said. "It is a good guess. A big oil company will not continue to operate a property at a loss anymore than will a little company."

—The End

Bethlehem Power Pumps for General Service





Whenever you need a pump for gathering or pipe-line work, general service around a rig or lease, salt-water handling or disposal, refinery or terminal service, Bethlehem can meet your requirements. From Bethlehem's expanded line of duplex and triplex power pumps, you can select exactly the right unit to handle the fluid you wish to move.

Outstanding features of these general-service pumps include:

- Positive lubrication throughout the power end over the full speed range.
- An adequate choice of fluid ends, with the proper trim for each selection.
- Rugged power ends of high-strength alloy iron to withstand the full-load rating of the pump under 24-hour service.
- Adaptability of the entire line to speed-changer drive applications.

For further information, we suggest you phone or write our nearest office. We will be glad to supply complete details, and to recommend precisely the proper pump for the kind of job you have in mind.

The pumps are available in the following sizes and types:

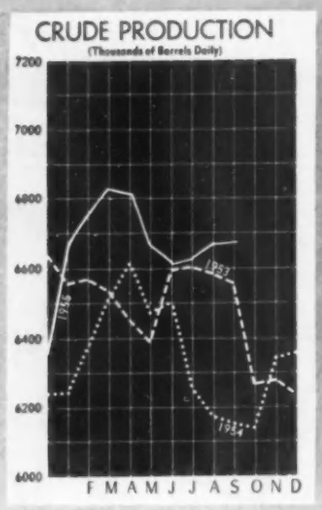
Model	Type	Input Hp	Bore & Stroke
U-33	Duplex	8	1¾ to 3 x 3
TP-3	Triplex	18	1¾ to 2¼ x 3
U-46	Duplex	24	2½ to 4 x 6
U-510	Duplex	100	3 to 5½ x 10

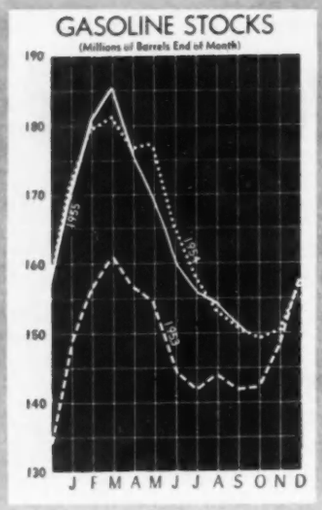
BETHLEHEM SUPPLY COMPANY

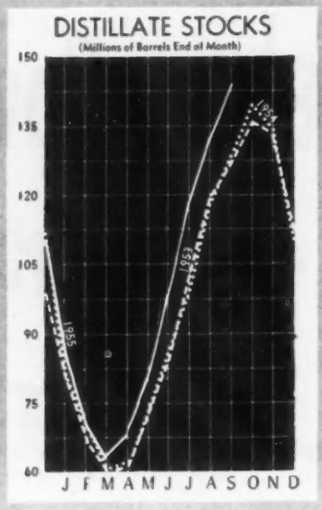
General Offices: 21 E. Second St., Tulsa, Okla.
West Coast Headquarters: Los Angeles, Calif.

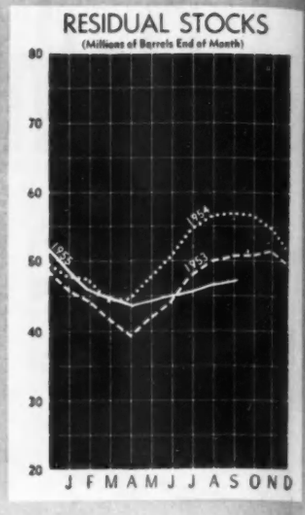
Export Distributor: Bethlehem Steel Export Corporation
25 Broadway, New York, N. Y.

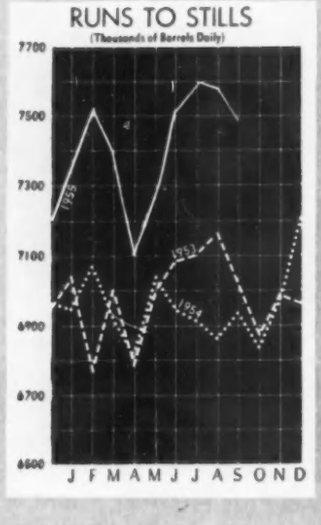
BETHLEHEM SUPPLY

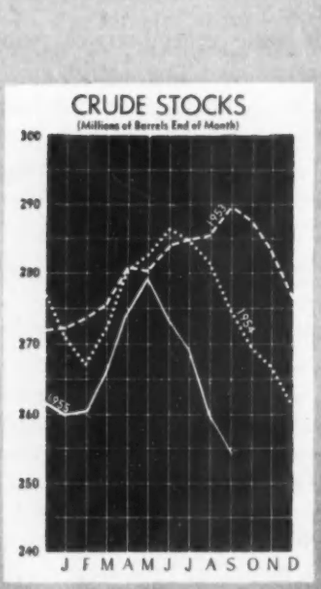












Petroleum Trends in U. S. . . .

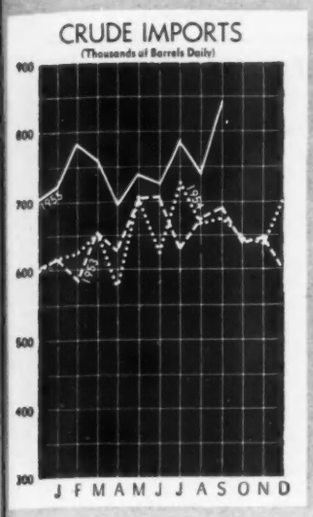
By CECIL W. SMITH, World Oil Staff

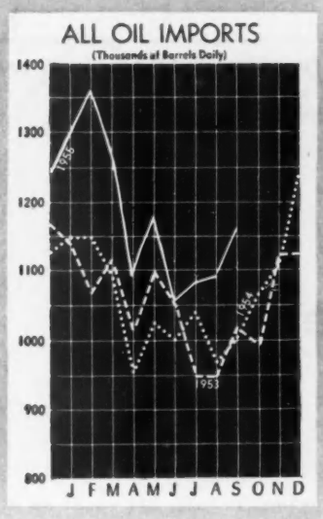
U. S. Crude Production by States

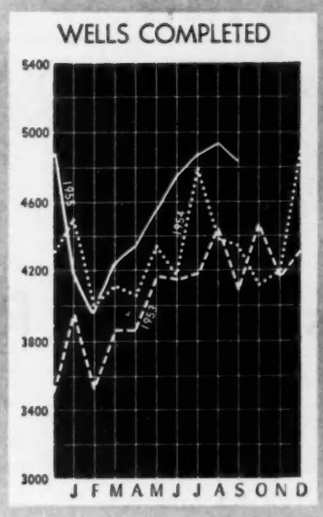
(THOUSANDS OF BARRELS)

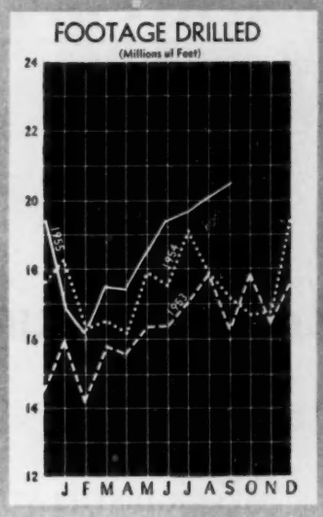
STATE or DISTRICT	DAILY AVERAGE PRODUCTION Sept., 1955	August, 1955	Sept., 1954	% Diff. Sept., '55-'54	TOTAL PRODUCTION First Nine Months 1955	1954	% Diff. '55-'54
Alabama	4.1	4.0	4.5	— 8.9	1,021	1,202	— 15.1
Arkansas	74.2	73.9	76.7	— 3.3	21,129	22,048	— 4.2
California	982.7	978.5	960.1	+ 2.4	265,713	267,573	— 0.7
Colorado	150.7	150.5	114.3	+ 31.8	37,095	29,942	+ 23.9
Florida	1.4	1.4	1.4	.....	363	416	— 12.8
Illinois	236.1	237.4	181.8	+ 29.8	61,160	48,753	+ 25.4
Indiana	30.2	31.0	29.0	+ 4.1	8,230	8,434	— 2.4
Kansas	315.4	328.6	321.4	— 1.9	90,299	89,376	+ 1.0
Kentucky	44.0	43.0	38.3	+ 14.9	11,215	10,179	+ 10.2
Louisiana	741.9	719.9	618.9	+ 19.9	196,686	186,663	+ 5.4
North Louisiana	115.7	116.6	106.5	+ 8.6	32,203	30,847	+ 4.4
South Louisiana	626.2	603.3	512.4	+ 22.2	164,483	155,816	+ 5.6
Michigan	30.8	30.8	32.5	— 5.2	8,504	9,056	— 6.1
Mississippi	104.2	101.2	89.4	+ 16.5	26,864	25,136	+ 6.9
Missouri	0.2	0.2	0.2	.....	52	63	— 17.5
Montana	42.1	45.4	39.7	+ 6.0	11,858	9,965	+ 19.0
Nebraska	28.8	29.5	21.6	+ 33.3	6,952	5,414	+ 28.4
Nevada	0.1	0.1	0.2	— 50.0	47	20	+135.0
New Mexico	228.6	227.9	203.1	+ 12.6	60,874	55,494	+ 9.7
Southeast New Mexico	227.1	226.3	201.1	+ 12.9	60,184	54,940	+ 9.5
Northwest New Mexico	1.5	1.9	2.0	— 25.0	690	554	+ 24.5
New York	10.6	10.8	9.6	+ 10.4	2,354	2,467	— 4.6
North Dakota	33.8	33.2	14.5	+133.1	8,099	3,931	+106.0
Ohio	12.4	12.4	10.0	+ 24.0	3,166	2,836	+ 11.6
Oklahoma	537.0	553.2	482.3	+ 11.3	149,641	141,317	+ 5.9
Pennsylvania	22.2	21.9	24.3	— 8.7	6,220	7,024	— 11.5
South Dakota	0.1	0.1	0.1	.....	26	23	+ 13.0
Tennessee	.....	.....	.....	.....	13	12	+ 8.3
Texas	2,745.6	2,734.2	2,606.9	+ 5.3	783,019	736,554	+ 6.3
Dist. 1—South Central	50.0	49.3	42.3	+ 18.2	13,876	11,456	+ 12.1
Dist. 2—Middle Gulf	145.0	141.7	135.6	+ 6.9	40,923	39,159	+ 4.5
Dist. 3—Upper Gulf	427.6	433.0	424.4	+ 0.8	123,792	120,447	+ 2.8
Dist. 4—Lower Gulf-S. W.	236.4	230.2	230.7	+ 2.5	66,579	66,994	— 0.6
Dist. 5—East Central	50.0	47.9	43.8	+ 14.2	13,151	12,150	+ 8.2
Dist. 6—Northeast	123.8	995.0	322.4	— 61.6	94,092	93,887	+ 0.2
Dist. 7-B—North Central	145.8	143.0	133.6	+ 9.1	38,640	34,519	+ 11.9
Dist. 7-C—West Central	169.9	173.6	176.6	— 3.8	50,273	49,359	+ 1.9
Dist. 8—West	904.0	908.2	831.8	+ 8.7	255,142	233,196	+ 9.4
Dist. 9—North	196.2	195.1	181.4	+ 8.2	54,068	50,907	+ 6.2
Dist. 10—Panhandle	90.2	90.0	84.1	+ 7.3	24,029	22,475	+ 6.9
Utah	6.6	6.6	5.3	+ 24.5	1,601	1,413	+ 13.3
Virginia	0.1	0.1	.....	.....	13	7	+ 85.7
West Virginia	6.4	6.5	8.2	— 22.0	1,767	2,221	— 20.5
Wyoming	277.4	284.2	256.5	+ 8.1	74,727	70,006	+ 6.7
Total United States	6,667.6	6,666.5	6,150.8	+ 8.4	1,838,708	1,737,545	+ 5.8

Source: Bureau of Mines and API. Texas districts data from API and do not necessarily agree with State totals.









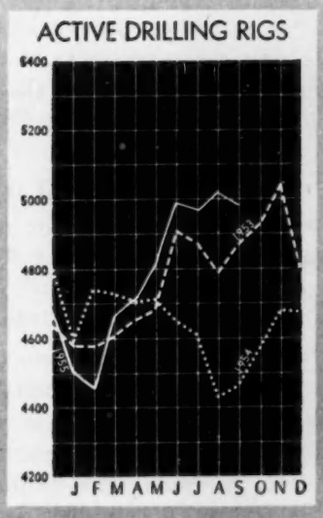
- **Oil imports highest since March**
- **Footage drilled at monthly peak**
- **Active rigs ease, but still high**

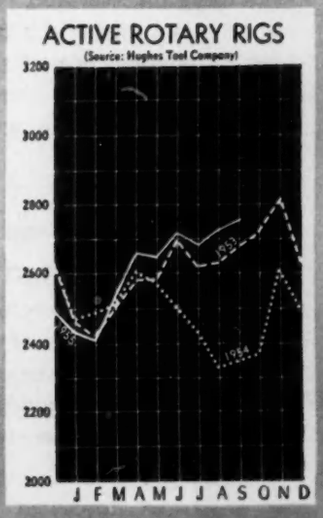
Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1953:											
June	6,595	7,081	283,715	3,467	146,196	1,462	84,504	1,238	43,801	707	1,050
July	6,603	7,103	284,976	3,583	143,916	1,441	102,394	1,224	47,966	629	946
August	6,583	7,163	285,352	3,592	146,050	1,437	119,542	1,222	50,007	672	946
September	6,557	7,023	289,614	3,521	144,184	1,448	126,709	1,203	50,516	692	1,013
October	6,262	6,872	287,541	3,437	144,495	1,462	135,409	1,184	50,820	639	990
November	6,277	6,987	283,021	3,528	150,747	1,463	133,381	1,223	51,267	648	1,120
December	6,238	6,964	276,676	3,628	159,949	1,441	111,944	1,247	49,370	598	1,121
1954:											
January	6,240	6,947	270,811	3,431	171,704	1,550	81,044	1,271	47,474	617	1,143
February	6,379	7,068	266,918	3,476	179,950	1,545	70,390	1,241	47,119	621	1,144
March	6,507	6,923	271,867	3,375	181,297	1,458	60,270	1,168	44,249	654	1,088
April	6,615	6,811	280,310	3,404	177,006	1,374	61,721	1,140	44,362	574	950
May	6,471	7,038	282,250	3,482	177,606	1,372	73,581	1,148	47,009	708	1,021
June	6,500	6,947	285,155	3,483	165,404	1,399	86,325	1,123	50,216	624	999
July	6,242	6,916	284,894	3,480	158,010	1,416	101,657	1,089	54,365	724	1,038
August	6,168	6,862	281,043	3,492	153,168	1,453	117,579	1,069	56,322	664	966
September	6,151	6,939	274,608	3,511	150,916	1,514	128,061	1,086	56,702	672	999
October	6,135	6,834	269,442	3,457	149,661	1,545	139,128	1,066	56,541	642	1,065
November	6,346	6,975	264,566	3,530	150,604	1,622	133,886	1,120	54,891	636	1,104
December	6,394	7,238	258,385	3,605	155,400	1,668	108,144	1,187	52,105	729	1,301
1955:											
January	6,761	7,379	260,156	3,639	169,562	1,740	86,692	1,235	49,457	739	1,348
February	6,835	7,549	258,630	3,655	181,643	1,847	68,513	1,239	46,042	751	1,379
March	6,886	7,374	264,430	3,543	183,972	1,703	62,457	1,185	44,970	742	1,319
April	6,887	7,136	275,232	3,502	175,601	1,534	70,139	1,110	43,838	697	1,123
May	6,677	7,281	276,948	3,605	168,751	1,519	83,559	1,111	45,083	742	1,137
June	6,613	7,484	270,850	3,725	157,439	1,628	100,652	1,080	44,398	764	1,159
July	6,632	7,580	264,601	3,824	157,079	1,575	119,169	1,091	44,894	860	1,161
August	6,666	7,579	259,680	3,778	153,694	1,713	132,345	1,106	46,550	743	1,090
September	6,668	7,484	254,775	3,683	151,266	1,611	143,722	1,088	46,754	846	1,162
Sept., 1955 Change:											
In Month	+2	−95	−4,905	−95	−2,428	−102	+11,377	−18	+204	+103	+72
In Year	+517	+545	−19,833	+172	+350	+97	+15,661	+2	−9,948	+174	+163
Week Ended:											
10-14-55	6,714	7,357	255,134	3,652	150,480	1,557	148,849	1,091	47,288	694	1,003
10-15-54	6,196	6,765	271,061	3,299	150,676	1,452	133,253	1,076	56,184	524	866

Source: Data for last two months from API; prior monthly data from Bureau of Mines.





By **RAY L. DUDLEY,** Publisher, and **WARREN L. BAKER,** Editor

Refinery Runs Must Be Reduced

FAR LARGER DISTILLATE STOCKS than ever before have been accumulated by U. S. petroleum refiners. A cold winter is needed to work them down to reasonable levels by next spring.

Unless consumption of heating oils is increased sharply by a cold winter, present high inventory volumes indicate that excessive stocks of distillate fuel oil will be a troublesome problem for the industry during 1956. A milder-than-normal winter would put the industry in a bad spot next year.

Therefore, it is essential that U. S. refiners exercise extreme caution during the next 5 to 6 months. They must guard against making too much distillate fuel oil, as well as against the usual winter problem of making excessive quantities of motor fuel.

It would be wise for them to hold crude runs to stills to reasonable limits, especially during the first few months of the winter so they can see how things are going by that time. It is encouraging to see a reduction in refinery crude runs during the last several weeks. Consequently, a desirable, sizable reduction in production of distillate oils took place. During the first two weeks of October, crude runs to stills averaged only slightly over 7¼ million barrels daily. In contrast, September crude runs averaged just under 7½ million barrels per day, and during the preceding two months they had been considerably over this figure. Holding of refinery runs around recent levels should be continued through the remainder of 1955. This action would greatly improve the outlook.

•

SULPLUS DISTILLATE STOCKS have been created by the high level of refinery output during the last four months. U. S. inventories of distillate rose 7¾ million barrels during the four weeks ended October 14, when they totaled nearly 149 million barrels. This was 15½ million barrels higher than stocks on hand at the corresponding season of 1954.

They will start downward in November, when cold weather can be expected in many U. S. areas. Therefore, the surplus quantities can be worked off pretty rapidly if refinery runs are held to around 7¼ million barrels daily. The success of the industry in getting rid of excessive distillate stocks during coming months will depend even more upon the unpredictable matter of weather.

With the largest inventories of heating oil in history on hand, prolonged cold weather is the industry's need.

•

FAVORABLE CONDITIONS EXIST so far as other stocks of the industry are concerned. Gasoline inventories total the same as a year ago. High demand has kept them at the same level as in 1954 despite larger refinery yields. Crude oil stocks are considerably below 12 months ago.

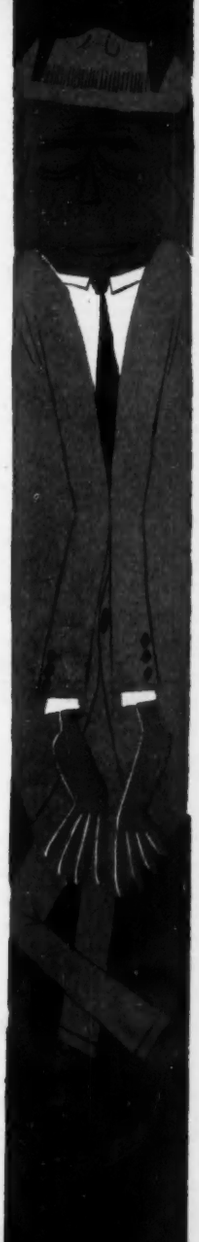
With more distillate in storage tanks than ever before, it will not be necessary for refiners to make large quantities of this product during the coming winter. Hence, nothing but a lack of willingness need prevent refiners from holding refinery runs to reasonable levels. This would make it possible for them to prevent the accumulation of too much gasoline during the off-consuming winter period. The outlook for gasoline is made more favorable by the existence of 2¾ million less barrels in the area east of California than on hand a year ago.

Meanwhile, U. S. crude oil stocks have been reduced sharply from a year ago. Current stocks are over 18 million barrels less than at the corresponding 1954 period. Consequently, the reduction of refinery runs will not have any adverse effect on the crude oil situation. This is true, even though higher crude oil production is anticipated during the last two months of the year.

Texas' allowable production for the month of November has been increased by nearly 75,000 barrels from the October level, and to the highest point since last April. However, inventories of crude oil are so much lower than a year ago, some additions to stocks would not be harmful.

The only worry of the industry is high distillate fuel oil stocks. This can be cured by cold weather or curtailment of refinery operations, without forcing troubles on some other phase of the industry.

Mr. "B" was in a BIND



When Mr. B. came to see us he was in a bind. He had borrowed on his properties in East Texas to buy some production in Louisiana. Now he discovered that he had a unit which was costing too much to operate. He told us that if he could buy the adjacent property he could work it with no additional equipment and get out of the woods.

We looked into his problem thoroughly, and when he returned we had two proposals to make. We told him we'd lend him enough to buy the new land, so that he would need only $30,000 in cash. But then we asked him if he had ever considered selling his part. We showed him the tax advantages and the excellent cash position it would put him in. He understood what we were telling him, and he sold. He got out from under a bad deal with enough cash to get into a deal which did pay out for him.

We lost the opportunity to make a loan, you say. Yes, but lending is not our only function. In the Oil Loan Department at The National Bank of Commerce we are trying to help and to develop independent oil men. If you have a difficult problem which needs impartial appraisal and advice based on experience, come to see us. This sort of help is why oil men **going up** come to the Oil Loan Department of The National Bank of Commerce.

E. O. BUCK, VICE PRESIDENT, OIL LOAN DEPARTMENT

THE NATIONAL BANK OF COMMERCE

OF HOUSTON

Gulf Building, Houston, Texas "The Bank for All the People"

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

Facilities of the Oil Loan Department of The National Bank of Commerce are available in Wyoming, Colorado, Nebraska, New Mexico, Texas, Louisiana, and Mississippi

U. S. Wells Completed in September and First Nine Months, 1955-1954

STATE or DISTRICT	NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR SEPTEMBER: Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	TOTAL NEW WELLS: Sept. 1955	Aug. 1955	Sept. 1954	Total Footage Sept., 1955	DETAILS FOR JANUARY-SEPTEMBER: NEW WELLS: 1955	1954	Percent Diff.	FOOTAGE: 1955	1954	Rigs in Operation: Sept., 30, 1955	Aug. 31, 1955	Sept. 30, 1954
Alabama				1				1	4	4	3,883	35	57	— 38.6	145,878	300,715	6	6	4
Arizona												4	8	— 50.0	16,136	30,774	1	1	1
Arkansas	45		1	35				81	82	68	265,492	576	440	+ 30.9	1,898,893	1,552,133	58	63	31
California	135		6	51				191	185	195	1,007,744	1,776	1,849	— 4.0	8,826,264	8,396,097	248	240	203
Colorado	45		7	92				144	132	94	792,119	1,135	956	+ 18.8	6,089,545	5,268,676	102	111	60
Florida				3				3	1	2	87,757	24	26	— 7.7	221,836	159,014	2	4	3
Georgia				1				1			4,130	1	7	— 85.7	4,130	18,008	2	1	1
Idaho												3			11,337				
Illinois	175			176				351	316	292	858,327	2,793	2,308	+ 21.0	6,753,108	5,622,264	294	348	292
Indiana	17			28				45	57	91	75,781	450	637	— 29.4	682,254	966,733	105	101	124
Kansas	184		24	199			3	410	351	379	2,162,173	3,462	3,175	+ 9.0	13,272,134	11,211,421	456	494	412
Kentucky	69		17	64				150	166	110	192,197	1,205	1,030	+ 17.0	1,865,590	1,928,985	131	131	93
Louisiana	213	20	17	140			2	392	345	356	2,643,293	3,087	2,688	+ 14.8	19,944,842	16,661,204	381	414	273
North Louisiana	128	2	9	62			1	202	161	210	707,981	1,572	1,423	+ 10.5	4,784,646	4,180,895	90	95	60
South Louisiana	85	18	8	78			1	190	184	146	1,935,312	1,515	1,265	+ 19.8	15,160,196	12,480,309	291	319	213
*Gulf of Mexico	27	5	2	10				44	26	33	409,802	247	176	+ 40.3	2,307,082	1,618,541	51	38	32
Maryland																	4	2	5
Michigan	23		3	29				55	51	51	159,134	392	413	— 5.1	1,160,626	1,086,495	84	95	101
Mississippi	14		1	25				40	22	38	294,318	340	310	+ 9.7	2,538,783	2,172,936	43	42	47
Missouri												24	9	+166.7	13,095	9,531	3	5	2
Montana	15		1	26				42	46	36	186,039	255	259	— 1.6	1,252,907	1,014,199	52	55	36
Nebraska	37		1	58				96	79	52	562,451	620	325	+ 90.8	3,601,407	1,809,308	47	56	27
Nevada												6	10	— 40.0	44,828	51,218	1	1	3
New Mexico	108		46	19				173	112	119	731,132	1,268	899	+ 41.0	5,412,048	4,740,705	165	147	115
New York	21				13			34	40	43	46,728	266	451	— 41.0	367,296	658,396	49	56	64
North Dakota	14			15				29	24	27	178,861	189	210	— 10.0	1,316,191	1,471,332	29	26	27
Ohio	59		22	24				105	131	73	217,963	879	774	+ 13.6	1,846,191	1,499,159	213	223	188
Oklahoma	362	1	39	245	6		8	661	736	554	2,492,183	5,710	5,994	— 4.7	19,784,493	20,362,206	626	620	700
Oregon												1			7,101		1	1	
Pennsylvania	20		21	4	16	5		66	67	62	125,440	550	750	— 26.7	1,039,323	1,361,621	125	119	131
South Dakota				2				2	1		5,492	9	16	— 43.8	43,791	90,641	2	3	2
Texas	959	20	46	572	13		1	1,611	1,864	1,545	6,792,619	14,582	13,807	+ 5.6	64,058,408	62,207,947	1,426	1,339	1,239
Dist. 1: South Central	99			47				146	135	120	397,800	1,305	842	+ 55.0	3,439,827	2,804,148	58	54	33
Dist. 2: Middle Gulf	26	2	3	26				57	86	79	304,723	601	617	— 2.6	3,567,071	3,734,922	41	44	30
Dist. 3: Upper Gulf	62	6	5	68				141	150	142	890,525	1,328	1,320	+ 0.6	8,495,855	8,890,899	147	137	123
*Gulf of Mexico	1	5		4				10	1		99,182	10			99,182		4	3	2
Dist. 4: Lower Gulf-S.W.	40	11	7	45	1			104	123	102	553,854	1,017	1,089	— 6.6	5,386,112	5,701,395	78	81	60
*Gulf of Mexico	2	6		4				12	1		115,549	12	1		115,549	9,980	2	3	1
Dist. 5: East Central	4			13				17	22	25	61,946	197	213	— 7.5	763,771	807,488	21	13	11
Dist. 6: Northeast	39		6	28				73	61	72	313,943	536	544	— 1.5	2,848,934	3,195,496	60	57	52
Dist. 7-B: North Central	116		4	98				218	309	291	696,679	2,309	2,213	+ 4.3	7,365,702	7,077,774	172	165	127
Dist. 7-C: West Central	48		1	21				70	115	118	365,133	887	992	— 10.6	4,878,536	5,141,783	119	109	140
Dist. 8: West	244		3	54	3			304	458	243	1,657,348	2,846	2,194	+ 29.7	15,558,450	13,041,026	392	384	343
Dist. 9: North	211	1	1	165	9		1	388	316	274	1,221,842	2,816	3,035	— 7.2	9,128,707	9,324,184	246	215	240
Dist. 10: Panhandle	70		16	7				93	89	79	328,826	740	748	— 1.1	2,625,443	2,488,832	92	80	80
Utah	2		1	13				16	5	11	59,651	79	47	+ 68.1	351,615	218,214	27	24	29
Washington																			1
West Virginia	4		55	9				68	60	72	187,547	477	414	+ 15.2	1,249,390	1,202,484	191	188	171
Wyoming	33		1	33				67	62	69	399,731	543	879	— 38.2	2,740,368	4,632,865	113	103	82
Total United States	2,553	41	309	1,864	48	5	14	5,834	4,939	4,343	20,532,185	40,741	38,748	+ 5.1	166,559,808	156,705,281	4,987	5,019	4,467
Total Western Canada	224		2	65				291	322	151	1,314,674	1,982	1,538	+ 28.9	8,508,193	6,117,530	225	220	121

* Gulf of Mexico wells are included in their respective district totals.

Completions Hit Daily Peak

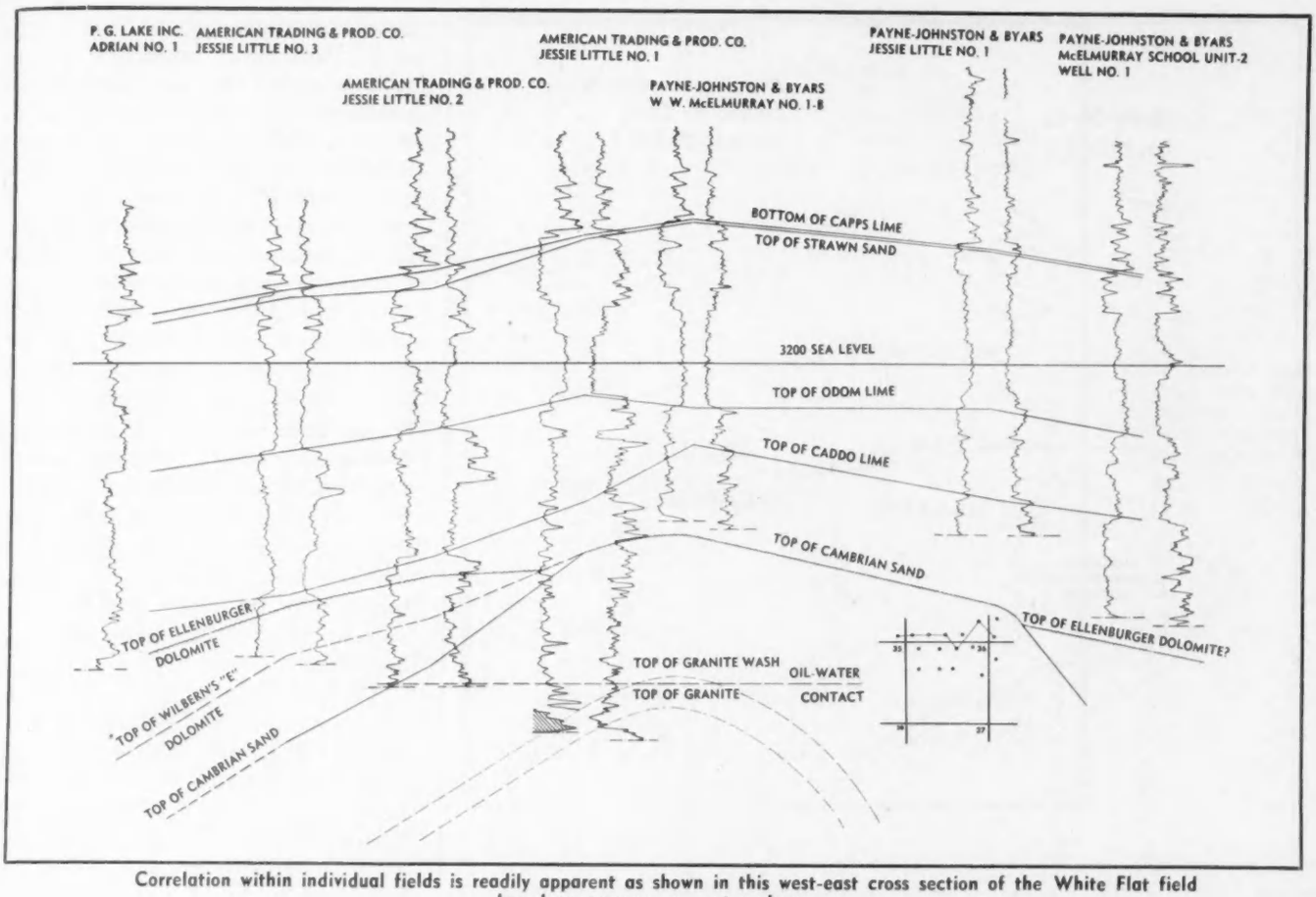
September averages 161 wells per day.

U. S. DRILLING activity continues to mount and September's rate topped all of the year's previous months. Total wells completed during the period was not the greatest this year, but with completions put on a daily basis, September hit a new high of 161 wells per day. The previous high had been 159 daily in both August and June. However, August's 4939 total is still the year's highest.

September's operations boosted the year's total wells to 40,741, which was 1994 wells, or 5.1 percent, more than the 38,748 recorded in the first nine months of record-breaking 1954. It appears that activity in the year's remaining three months will continue at a rapid pace, and that total wells will come close to WORLD OIL's 1955 forecast of 55,267.

Total footage represented in September's wells was at the year's high —20,532,185 feet. That ran the nine-months' total to 166,559,808 feet, which was 6.3 percent greater than 156,705,281 drilled in the comparable period of 1954. Therefore, footage drilled increased somewhat more this year than did the number of wells. The answer, of course, is that average well depth increased. So far this year, each test was drilled to the average depth of 4088 feet, while a year before the average was only 4044 feet.

There was little difference in the degree of success in this year's drilling campaign compared with last year's. In nine months, 61.3 percent of all wells drilled proved to be producers, while a year ago the score had been 61.2 percent. However, there were slight differences within the types of producing wells. This year, 55.3 percent of total drilled were completed as oil producers, and in 1954, oilers amounted to a slightly less 54.7 percent. The balancing difference took place in the natural gas and gas-distillate wells. Those wells amounted to 6.0 percent in 1955, and in 1954 they accounted for 6.5 percent of the total.



Correlation within individual fields is readily apparent as shown in this west-east cross section of the White Flat field based on gamma ray-neutron logs.

Cambrian Production Opens New Trend in West Texas

More than six new fields discovered in pre-Ellenburger rocks.

Drilling yields prolific wells at depths of 5500 to 6000 feet.

Such commercial production from Cambrian is geographically unusual.

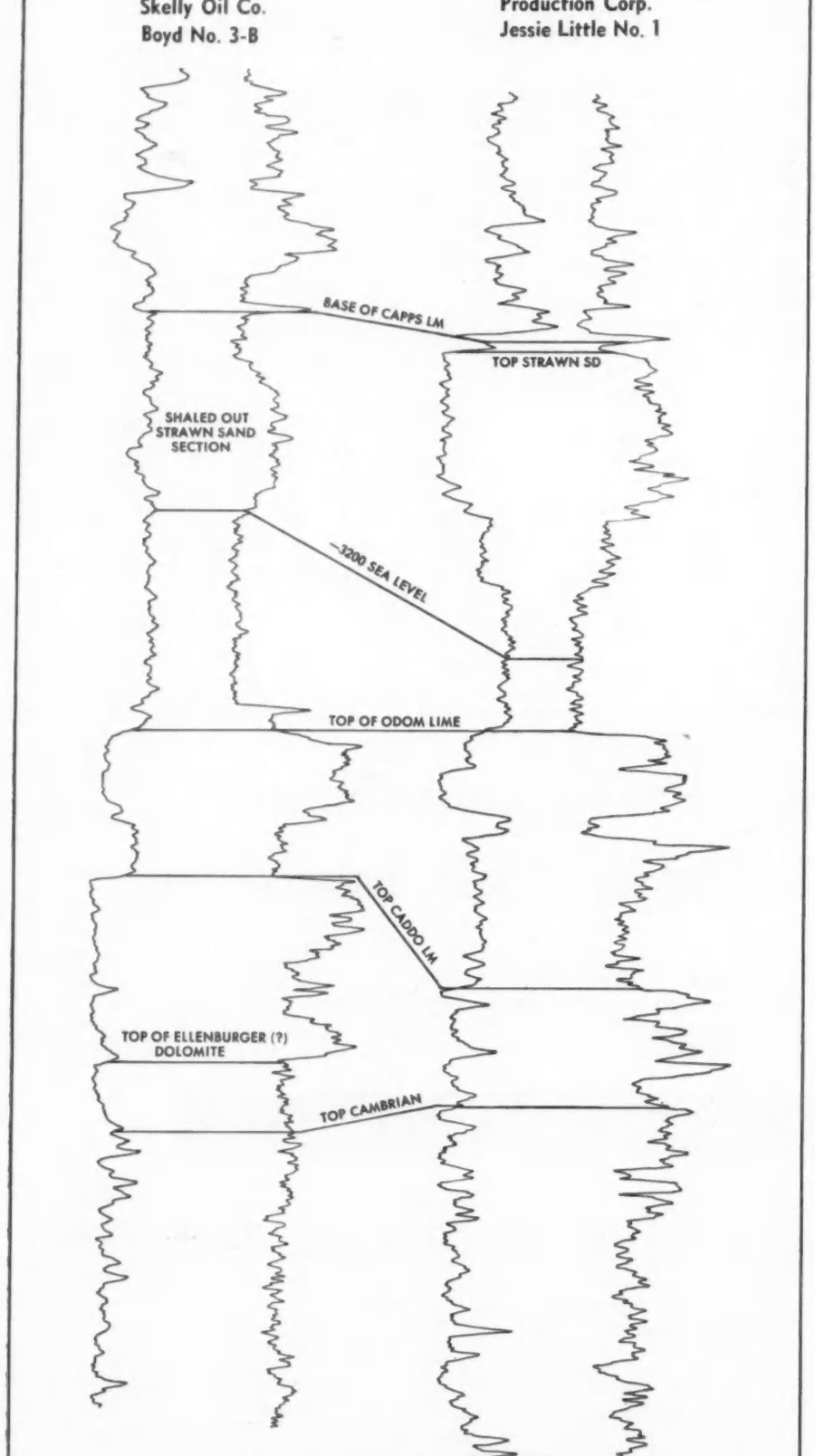
By **AARON W. COOK,** Lane-Wells Company, Abilene, Texas

RECENT DISCOVERIES along the eastern platform of West Texas opens a new trend in pre-Ellenburger rocks of Cambrian age which will add millions of barrels of new oil to present reserves. This new trend extends south and a little to the west through Taylor, Nolan and Coke counties, with the limits still undefined. The trend is especially attractive because it is reasonably shallow.

Prior to recent discoveries, the only other pre-Ellenburger production in Texas is recorded as a single well in Pecos County, Gulf Millar 3, presently producing from a "Basal" sand from 4380 feet to 4395 feet. This well has produced some 60,000 barrels of pre-Ellenburger oil since April, 1942.

Cambrian Trends. Relatively little is known of Cambrian rocks, although Cambrian sediments have been penetrated in almost every basin of the United States producing from Paleozoic rocks.

Commercial production from the



Typical example of similarities between radioactivity fields is found by comparing the logs on Skelly Oil Company 3-B in the Dora North field and American Trading and Production Corporation's Jessie Little 1 in the White Flat field.

Cambrian at the present time is limited to three western states—Texas, Kansas and Wyoming. Kansas has produced over 48 million barrels of oil from the pre-Ellenburger or pre-Arbuckle Reagan. Wyoming, perhaps, until recently, has had the largest single reserve of Cambrian oil in the U. S. namely, the Lost Soldier field in Sweetwater County, with an estimated ultimate recovery of 13 million barrels of oil.

Rocks of Cambrian age are exposed in the Llano uplift of Texas, the Arbuckle and Wichita mountains of Oklahoma and in the Ouachita mountains of southern Oklahoma.

In Texas and southern Oklahoma, the Cambro-Ordovician boundary falls within thick limestone units (Ellenburger and Arbuckle), and the division has been largely based on paleontologic evidence.

The initial Cambrian play along the eastern platform began with the completion of Humble Oil & Refining Company's Butner 3 located four miles north of Bronte in northeastern Coke County. It was completed in the Wilberns dolomite with a potential of 483 barrels of oil per day on a $^{16}/_{64}$-inch choke. This well was cased through the section and perforated with 96 holes from 5541-53 feet. This was a geological problem "child" because the Wilberns sand had not been productive elsewhere in the Permian basin.

Many miles to the north in Nolan County, the American Trading and Production Corporation found flowing production from the Cambrian sand in the Jessie Little 1 of the White Flat field. This is today considered a multi-pay field. An offset, the Jessie Little 2 discovered flowing production in the Wilberns dolomite of the Cambrian.

Drilling Trends. These isolated Cambrian discoveries had little significance until the Kilroy Company of Texas brought in their C. J. Roberts 1, a Cambrian sand discovery, completed with a flow of 1,293.48 barrels of oil per day from 51 feet of pay at a total depth of 6120 feet. Oil tested 52.0°, and the flow was natural through a

½-inch choke. This discovery activated a new drilling program. It proved that the Cambrian discoveries at White Flat and the Rawlings field were accountable for they were control points along a definite Cambrian trend.

Many operators believed that there would be many more structural traps along this trend that extends through the Bronte field on the south and the White Flat on the north.

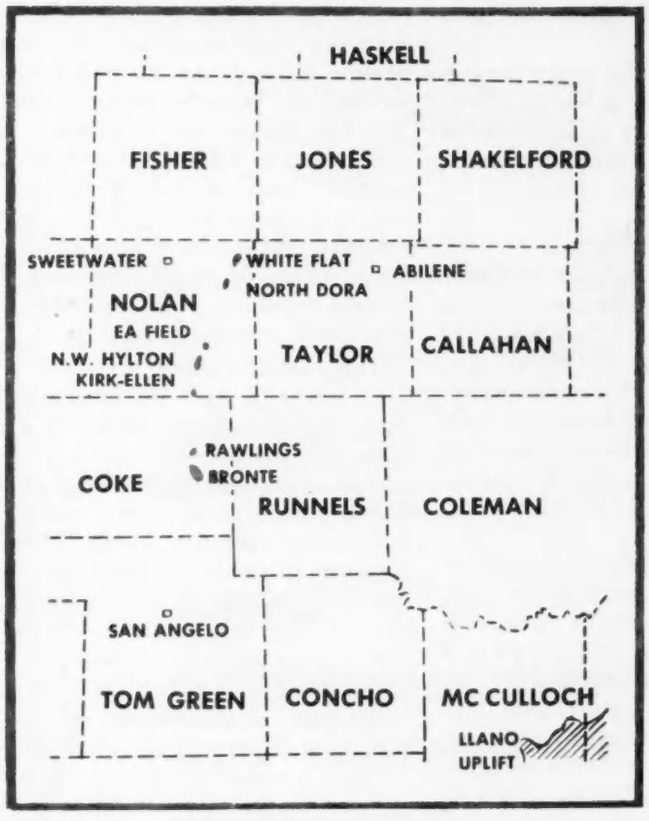
Subsequent drilling along this trend has produced some very prolific wells and some new fields. Progressing at the southern end of the trend two miles southwest of Bronte in the Bronte field, Humble Oil & Refining Company's O. M. Keeney 5 was completed in the Cambrian sand with a flow of 552 barrels of oil per day on a ¼-inch choke. Four miles north of Bronte in the Rawlings field previously mentioned, Humble Oil & Refining Company's 3 flowed 483 barrels per day from the Wilberns.

One mile east of Blackwell in Nolan County, Neville G. Penrose Mrs. K. H. Kirk 1 flowed 479 barrels of oil per day from a dolomite identified as the Wilberns, later being designated as the Blackwell East (Wilberns) oil field. Further north, four and one-half miles northwest of Hylton in Nolan County in the North Hylton field, Seaboard of Delaware Billie Hanks 5-A was completed for 381.25 barrels of oil per day on a 18/64-inch tubing choke with 225 pound tubing pressure. Four miles southwest of the townsite of Nolan, two confirmation tests were drilled and completed as flowing from the Cambrian sand, offsetting the Kilroy of Texas Company discovery, and the Skelly Oil Company's Boyd 3-B, which flowed 1987 barrels of oil per day on a ¾-inch tubing choke with 300 pound tubing pressures. Previous completions in the Dora North field were in the Caddo lime and the Ellenburger dolomite.

White Flat. The largest field to date along this trend is the White Flat field, located in the extreme northeastern corner of Nolan County, Texas.

This field was discovered in October, 1952, with the completion of Payne-Johnston-Byers Jesse Little 1 in a thick reef-like Caddo limestone for a flowing potential of 720 barrels of oil per day. Commercial production was also indicated from the Strawn sand.

At the present time, there are seven recognizable producing formations in the field; they are the Cambrian sand, Wilberns dolomite, Ellenburger dolomite, Bend conglomerate, Caddo limestone, Odom limestone and the Strawn sand. The last four formations are Pennsylvanian in age.



New Cambrian trend in West Texas showing location of recent oil discoveries below the Ellenburger.

The first Cambrian production was discovered in American Trading and Production Corporation's Jessie Little 1, which was completed in June of 1953. A total of 207 feet of the Cambrian sand was cored and recovered. The well recorded a flowing potential of 857 barrels of oil per day from the Cambrian sand and an additional 443 barrels of oil per day from 50 feet of Strawn sand at a lesser depth.

Wilberns Sand. At first it was believed that this Cambrian sand should be called the Hickory, as this name had been given to all "Basal" sands encountered below the Ellenburger. However, subsequent development and further studies along the Cambrian trend have led to much controversy among the producer and consultants. At the present time it seems to be the consensus that the sand should be called the Wilberns sand.

Reservoir Data. Reservoir characteristics of the wells producing from these Cambrian sands are very good. Generally speaking, flanking wells have the better porosity and permeability. The west side of the high in the White Flat field has the better Cambrian sections, while the east side has a very good development of the Caddo lime.

The Cambrian sands in general are very glauconitic and are seldom found without at least a small amount of crystalline dolomite associated with them. The glauconite varies much in composition from a dark green, finely dispersed, granular texture, to a soft shale-like substance. The sands range from large well rounded grains to sand grains of a sub-angular type generally unassorted. Generally speaking, the sand found in Skelly Oil Company's Boyd 3-B in the Dora North field was the best developed, well sorted and yet encountered. There were fewer impurities and less cementing material in the sands. Permeability readings, in some cases, exceeded 6000 millidarcys.

In some cases in the lower portion of the Cambrian section of the White Flat field, dolomite predominates with only a few large well rounded sand grains scattered throughout. The dolomite characteristics of the Cambrian section have been analyzed as being the same as the Wilberns'. There is

but one significant difference, and that is color.

The dolomite in the upper portion of the Cambrian is lighter in color than the Wilberns which justifies a different name, for there is little evidence from other data that could be separated otherwise.

Radioactivity Logging in Cambrian Trend. Most operators find that it is desirable to run radioactivity surveys after setting pipe when completing wells in the Cambrian trend. As most of these wells have more than one pay zone and probable water drives, it is the practice to set through, run a gamma ray and neutron log, and perforate.

In the Dora North field, separate wells are drilled to each of the pays, which normally results in three wells to a 40-acre location, one to the Cambrian sand, one to the Ellenburger dolomite, and one to the Caddo lime. In the White Flat field, all pay zones from the Caddo lime down, are designated as the White Flat pay, and wells are dually completed with the shallower Strawn sand formation.

Correlations within the individual fields are facilitated through the use of the gamma ray-neutron log; this is readily apparent from the cross-section of the White Flat field. A consistent marker is found at the base of the Capps lime, which appears as a low intensity gamma radiation and a fairly high neutron radiation. The Strawn sand section, which lies below the Capps lime, has an exceptionally low gamma radiation due to two factors—the lack of impurities in the sand, and a high lime content.

The neutron log is very reliable in picking porosity in this particular zone. The over-all Strawn section, that is the clean sand as well as the shaly sand, is very consistent in thickness over the White Flat and Dora fields, which indicates that this area was probably a peneplain during Strawn time.

The Odom lime appears next on the cross-section as a well developed tight lime in this particular portion of the field, with some porosity development in the southern part of the White Flat field. A thick reef-like Caddo limestone lies below the Odom lime. These wells have their best development on the east side of the high at White Flat.

The Caddo lime has a low gamma radiation and a high neutron radiation except in zones of porosity where the neutron shifts to the left and is very reliable for porosity determinations. The Ellenburger and Wilberns dolomite, which lie below the Caddo lime, normally have a gamma radiation similar to the overlying Caddo lime; however, the neutron intensity is lower, primarily due to presence of vertical fractures carrying fluid; this is a typical response in this area.

This fact is further borne out by the flanking wells in the field where water is encountered 30 to 40 feet above the known water table in the porous permeable Cambrian sand. The Cambrian sands have a relatively low gamma radiation, except for the presence of glauconite concentrations, which cause high radiations, because glauconite is high in potassium content and potassium is radioactive.

Another factor which causes fluctuations in radiation intensities in the Cambrian sands is the presence of varying concentrations of dolomite which tend to decrease the gamma radiations and increase the neutron radiations. Below the Cambrian sand, the granite wash, highly radioactive in this area, is encountered. It results in very high gamma radiations and low neutron radiations. The granite itself produces lesser gamma radiations and high neutron radiations.

Similarities between radioactivity logs in the various fields point out the value of these logs for regional correlation. A typical example can be found by comparing the logs on Skelly Oil Company's Boyd 3-B in the Dora North field, a Cambrian discovery, with the American Trading and Production Corporation's Jessie Little 1, the Cambrian discovery well in the White Flat field.

Completions. On the basis of a Railroad Commission hearing, all oil found from the top of the Caddo lime down is to be considered as one reservoir. Most of the wells in the field, where sufficient section lies above the water table, are dually completed in the Strawn sand and the White Flat pay. Cumulative production for the 49 wells in the field on May 31, 1954, was 1,208,185 barrels of oil. The White Flat pay accounted for 840,000 barrels from 43 wells, the Strawn sand 154,639 barrels from 24 wells, and the Odom lime with one well (formerly three) produced 13,546 barrels of oil.

American Trading and Production Corporation's Jessie Little 1 with a net effective pay section in the Cambrian sand section of 129 feet, with an average porosity of 11.9 percent by core analysis and an average permeability of 168.3 millidarcys, has a calculated reserve of 263.6 barrels of oil per acre foot or an estimated reserve for this one well of over 1,300,000 barrels of oil in the Cambrian sand. Conservative estimates place the cumulative reserves of the White Flat field at over 15,000,000 barrels of oil.

Along this Cambrian trend, the depth range of production is from 5400 to 6300 feet. Operators in this area, who in the past scheduled their test to the Ellenburger, are now in most cases, where possibilities exist, projecting them to the Cambrian.

Accumulation. The key to production, as always, lies in structural attitudes and source bed factors. Indigenous oil is not ascribed to the Cambrian beds, but migration into them from tightly compacted source rocks must explain the prolific accumulations. This fact is borne out at White Flat for example, as all production from the top of the Caddo lime downward is assumed to be derived from the same reservoir.

Although confirmed anticlinal uplifts have yielded salt water from clearly defined Cambrian sections, the present evidence requires stratigraphic studies to determine truncated conditions and pinch-outs for oil accumulation. This study seems to be the presently considered necessary prerequisite.

ACKNOWLEDGMENT

The writer wishes to express his appreciation to the American Trading and Production Corporation and Arthur W. Neff, their division geologist for the Abilene area, for his assistance in compiling the data used on White Flat field and the preparation of the radioactivity cross-section of that field.

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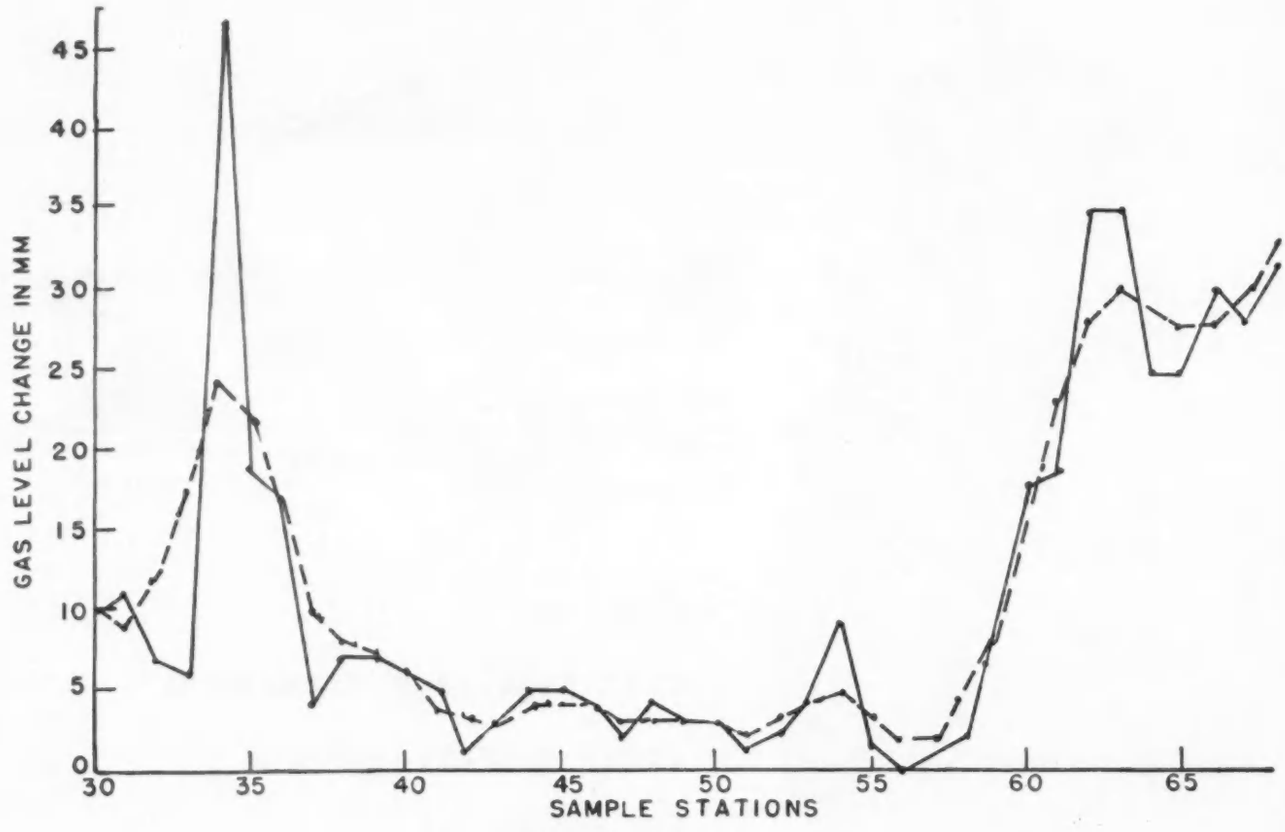


FIGURE 1—Field profile.

A Microbiological Method Of Prospecting for Oil

Research reveals that the presence of bacterial concentration may be indicative of hydrocarbon deposits.

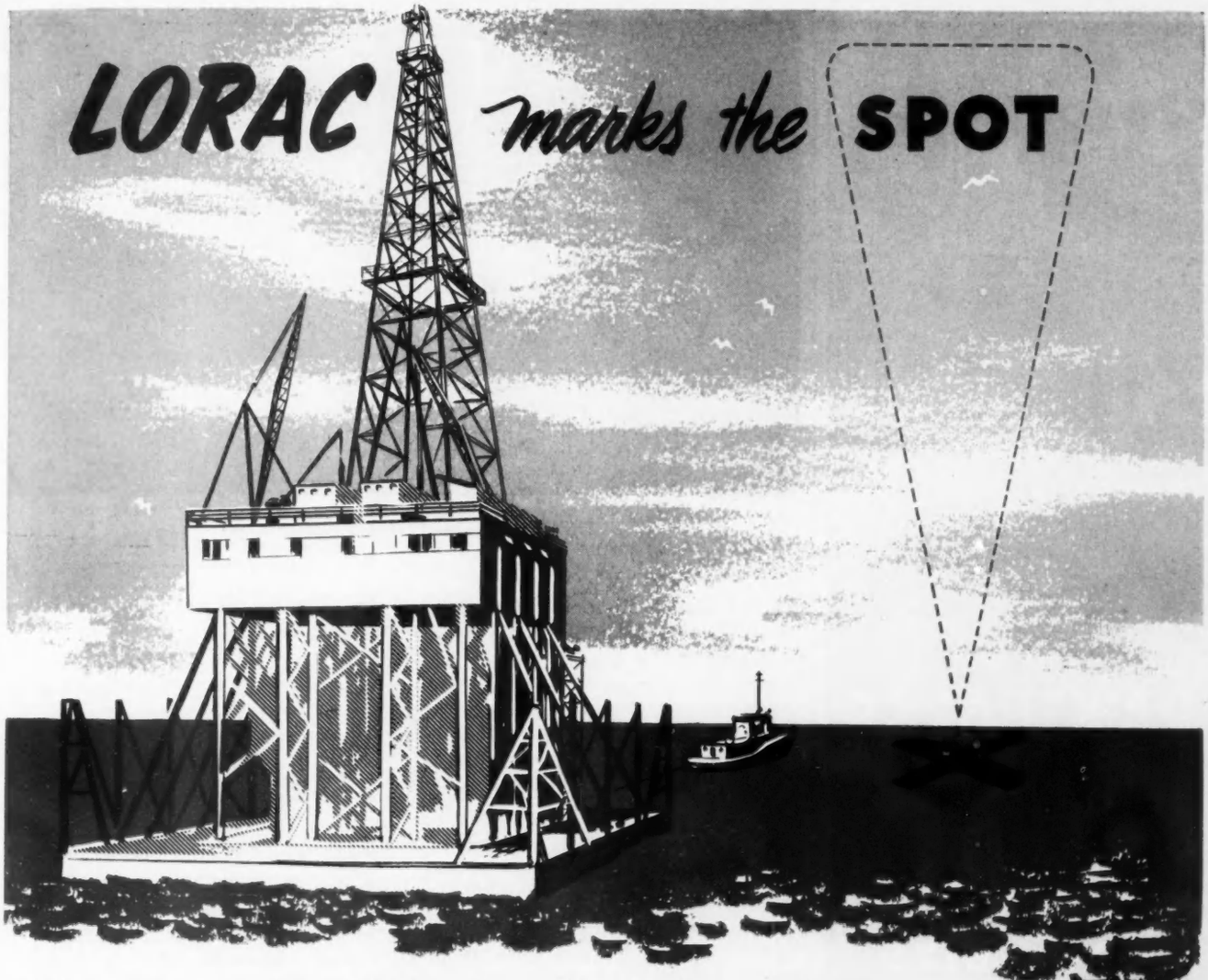
By DR. R. J. STRAWINSKI,
Louisiana State University,
Baton Rouge, La.

THE APPLICATION of microbiological techniques to the difficult problem of locating oil and/or gas deposits has been under consideration in recent years. Mogilevskii, a Russian geologist with a geochemical prospecting group, proposed in 1937 that bacteria which oxidize methane and other hydrocarbon gases would be found in subsoil which contained a higher concentration of these gases.[1] Aware of the negligible concentrations of hydrocarbons in soil even over known oil fields as established by gas surveys, he reasoned that this small but steady supply of gas was the determining factor which makes it possible for these bacteria to grow. Therefore, detection of these organisms in unusual numbers would indicate the presence of gaseous hydrocarbons in the subsoil which in turn would indicate the presence of a subterranean deposit.

In spite of an overly simplified qualitative procedure, he and his associates were able to detect abnormal numbers of methane oxidizing bacteria in subsoils related to gas and oil producing areas. Davis and Updegraff[2] have reviewed the scientific literature available on the subject, whereas Beerstecher[3] has reviewed the several geomicrobiological patents that have been issued in the U. S.

The basic suggestion that microorganisms may be utilized as indicators of petroleum deposits appears to be sound. However, a review of the various procedures reportedly used to test this premise reveals that much could be done to improve on the soundness of the method, in particular, sampling. The importance of proper sampling seemingly cannot be over-emphasized. The samples taken must be representative of the given area for the results to have quantitative significance. This article is concerned with some of the aspects of such a procedure.[4]

Methods and Results. Soil samples were obtained at a depth of approximately 24 inches to avoid the surface detritus present and other variables which may change daily. Investigations conducted thus far indicate that satisfactory results can be obtained when a minimum of three equi-distant soil samples (25 feet apart) are ex-



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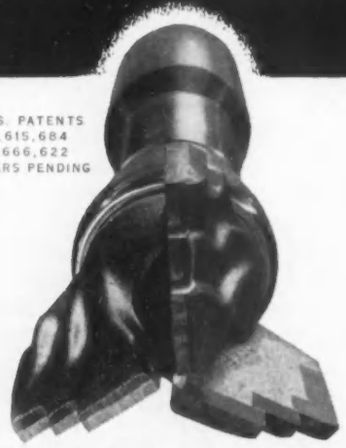

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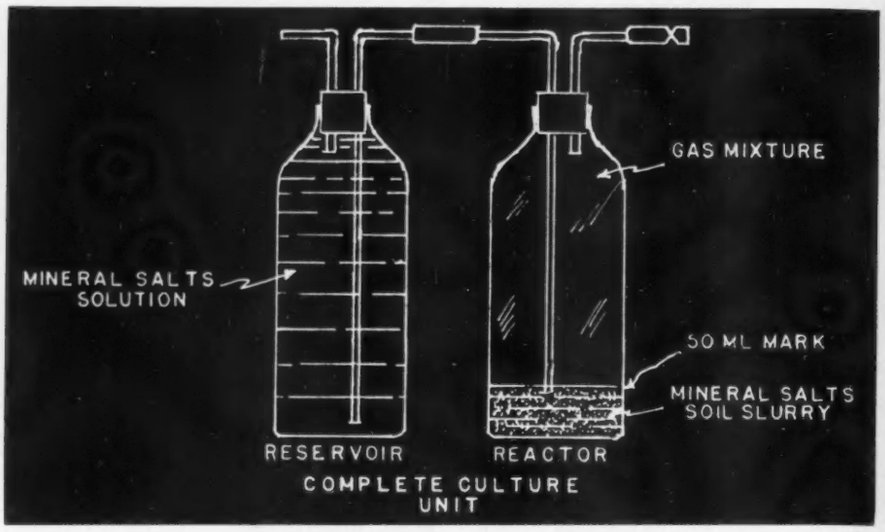

FIGURE 2—Modified Sohngen gas culture unit.

tracted from a 50-foot line to obtain a composite soil sample that is representative of the activity of the particular area sampled. The holes are drilled to approximately 30 inches, and the soil is removed. The entire side wall at the 24-inch depth is then scraped to expose fresh uncontaminated soil. The extra 6-inch depth at the bottom of the hole is generally sufficient to hold any soil remaining from the drilling and sampling operation, thus minimizing the possibility of contaminating the actual soil sample. Approximately one quart of soil is obtained from each of the holes in a so-called "station." Each sample is then screened by a U.S. standard sieve No. 18. One-third pint of each screened soil is then withdrawn and combined to provide a composite sample of one pint which is considered a representative sample.

The composite samples are suitably packaged and stored at 42° F. so that the microbial population is held substantially static until the samples can be further processed. Under these conditions the *in situ* activity can be preserved for as long as 4-7 days without any appreciable change in gas consuming activitiy. Storage at ambient temperature for only one day materially accelerates the gas consuming activity of the sample, so that the incubation time has been reduced as much as two and one-half days thus indicating a much higher degree of activity than the sample originally possessed. Therefore, the *in situ* rate of reaction, which is desirable in comparing the activity of the several samples, can be rendered entirely meaningless.

The nutrient media used can be varied widely. One of the media found to be satisfactory is prepared as follows: NH_4NO_3, 1.0g; $MgSO_4$, 0.1g; K_2HPO_4, 0.5g; $CaSO_4$, 0.1g, diluted to one liter with distilled water, final approximate pH 7.5.

In preparing for the determination of activities, the soil samples are removed from storage and the composite pint of soil is placed in a blendor, 700 ml medium is added and the mixture stirred for one minute. The speed of the blendor is then reduced to a rate above that at which layering or any separation occurs so that a proper

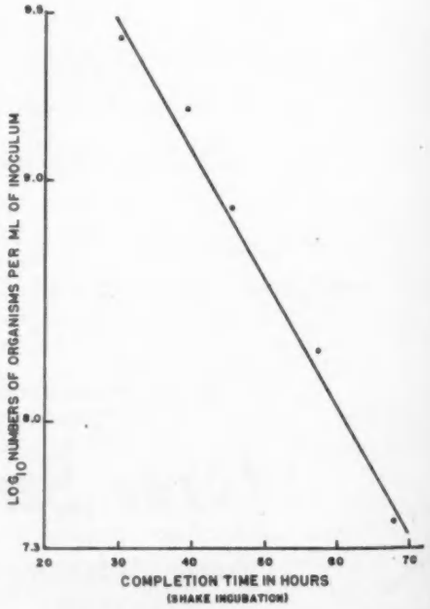

FIGURE 3—Effect of inoculumsize on methane completion time.

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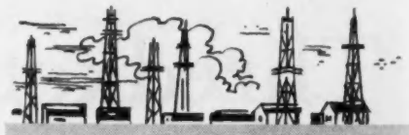
aliquot of the sample can be obtained for the test. The pH is adjusted, if necessary.

A siphon tube is inserted approximately two inches or more, if several aliquots are desired, below the surface of the soil medium-slurry in the blendor jar and siphoning action is started. The siphon tube is then connected to the reactor (250 ml glass prescription bottle) which had previously been filled with a test gas mixture (65 percent hydrocarbon gas, 30 percent oxygen and 5 percent carbon dioxide) permitting 50 ml of the sample slurry to flow into the reactor to a calibration mark. The soil slurry is constantly agitated during withdrawal of the aliquot. The reactor is then clamped shut. If the soil slurry is too viscous to flow, it may be removed with a pipette. The reactor is then connected to a reservoir (same size bottle) which has been filled previously with the same medium used in preparing the soil slurry. The tubing (see Figure 2) is so arranged that a siphoning system is achieved with the short tube on the reactor clamped shut and the short tube on the reservoir left open to the atmosphere. It has been consistently noted that if the procedure outlined is followed, the degree of activity of composite samples from a given station area will yield practically the same results 9 out of 10 times. Therefore only one culture unit need be set up for any one station to obtain representative results, thereby saving time, much space and equipment.

The complete culture unit is then incubated at about 28-30° C. After standing for some time some of the medium from the reservoir passes into the reactor because of the negative pressure created by the consumption of the gas in the reactor by microorganisms in the soil sample. This process will continue until completion of the reaction due to the exhaustion of the oxygen which was set to be the limiting factor under these experimental conditions. In the case of methane a liquid level of approximately 100 ml indicates the desired completion point of the reaction. If desired, the validity of the reaction can be determined by analysis of the residual gas mixture.

It was found to be accurate and expedient to read the gas consumption level of all samples on the day that the first samples reach the completion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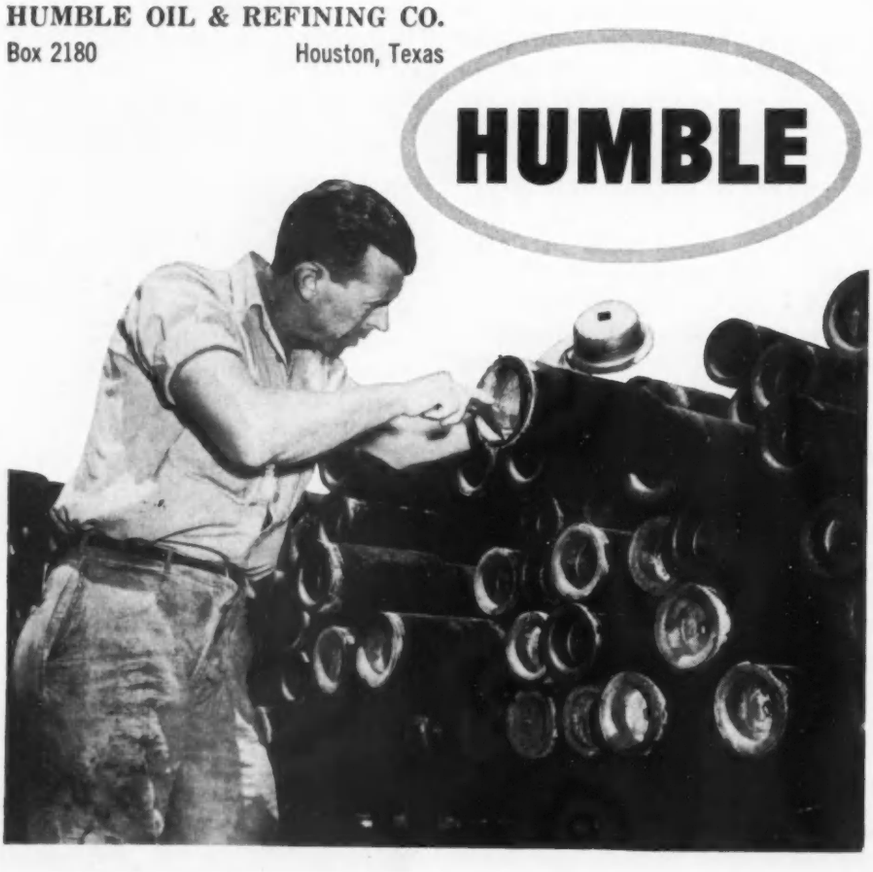

point. In some instances where only one or two samples complete their activity on the first day, then the second day can be considered the first day, if a larger number of samples complete their activity thus ruling out the possibility of "freak samples." Then gas consumption of all samples is measured.

The test gas employed to demonstrate the method was methane and the gas level change was measured in mm. (One mm equals 2.2ml.) Referring to the profile in Figure 1, the solid line illustrates the relative activities (gas level changes) of the various composite samples collected at the preferred 250-foot spacing. Some variation in activity is obtained from station to station which is probably due to natural and experimental causes. To average these variations a 3-total, 3-total moving average statistical method was adopted which produced the least distortion of the actual data. It can readily be seen how close the actual data compare to the calculated data as represented by the broken line. It is quite apparent from the profile that normal background activity can be easily differentiated from the abnormal or anomalous activity. A frequency distribution curve can be constructed for a large number of samples such as obtained from a field trial from which the abnormal level can readily be determined. The abnormal values so determined can then be suitably plotted to obtain contours.

Employing the method as described above, incubation time for the first abnormal samples to reach the completion point has been found to range from 6-8 days when samples are incubated under stationary conditions. However, if the culture units are agitated during incubation at 180 revolutions per minute on a rotary action shaker, the completion time is significantly reduced. For example,[5] the incubation time for methane, ethane, propane and butane was decreased by ½ to ⅓ depending upon the particular test gas employed. This is particularly important when working with gases other than methane since the completion time under stationary conditions is much longer. The reaction is therefore conducted under more optimum conditions which allow better contact amongst the reactants. The saving in the time factor gained from agitation is quite appreciable.

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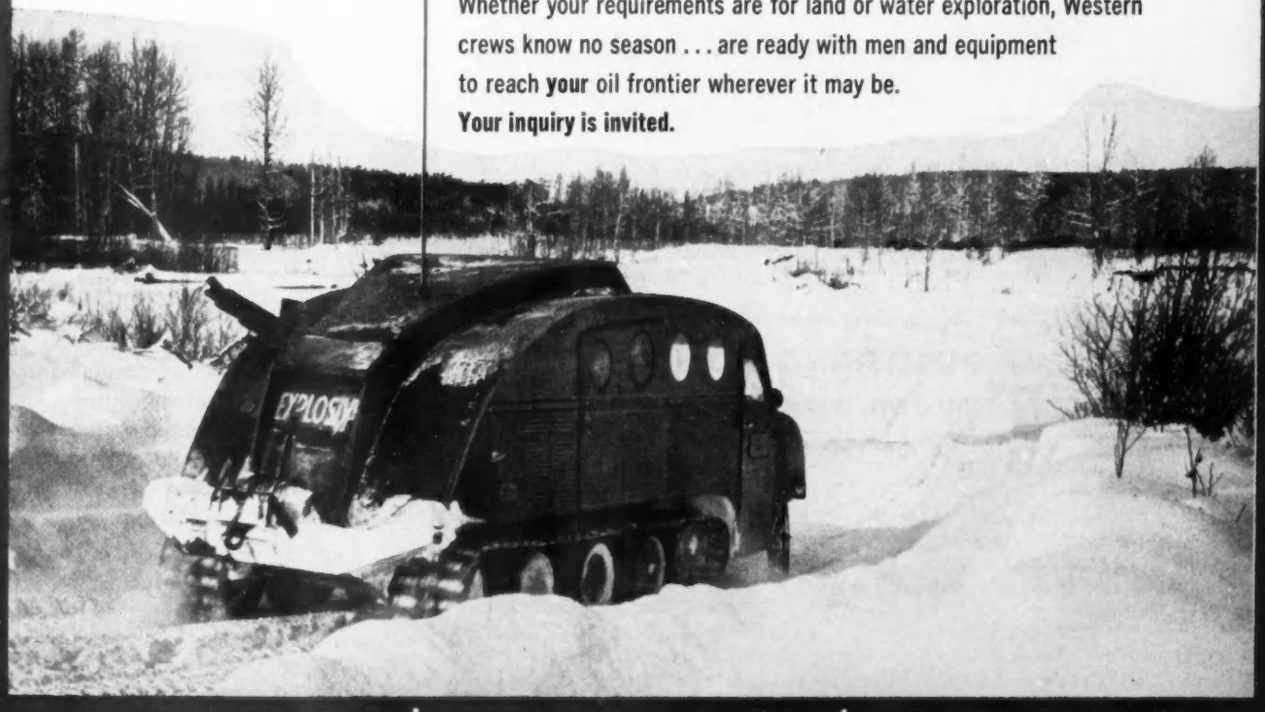

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the number of organisms in the inoculum is important when attempting to evaluate the relative activities of samples. For example, as demonstrated with an enrichment culture in Figure 3, it can be seen that the time at which completion of gas consumption occurs decreases with an increase in inoculum size. The completion time is a linear function of the logarithm of the number of organisms in the inoculum. The fact that one is dealing with a geometric function and not an arithmetic one should be borne in mind when interpreting relative microbial activities of soil samples for contouring purposes.

Summary and Discussion. A quantitative microbiological procedure has been described in its various aspects which can be employed for the detection of hydrocarbon gases in subsoils. Every effort was made to obtain a representative sample in the field as well as in the laboratory. Preservation of the soil sample was also stressed because the final results would be quantitatively meaningless without proper preservation. The test period can be substantially decreased if the soil culture units are agitated during incubation. The effect of inoculum size on completion time was shown to be a linear function of the logarithm of the number of organisms originally present.

The principle that probably permits the utilization of microorganisms as sensitive indicators of hydrocarbon gases in subsoils rests on the fact that there is a continuous passage of gas, albeit a very small amount. The continuous or constant supply of gas will support more organisms than would be expected from the amount of gas present at any given moment, as determined by chemical means.

Since the initial report by Mogilevskii[1] in 1940, the Russian literature continues to show an interest in microorganisms as indicators of oil and gas deposits. A review by Subbota in 1954 of a book by Mogilevskii reports that out of 20 microbiological anomalies 16 were proven by drilling. In the light of the present exploration situation in this country, this report, to say the least, is startling. In the United States, several patents have been issued in recent years. At the present time, it is well known in the industry that some companies are investigating the possible use of microbiological techniques

as a tool in prospecting for oil. The information accumulated thus far has not been made available in the scientific literature.

It appears that the so-called "geomicrobiological" techniques will develop into a useful tool in prospecting. However, the method should be used in conjunction with established prospecting procedures. Geophysical anomalies should be correlated with geomicrobiological anomalies whenever possible. The two procedures are entirely complementary in that one is based on the definition of a subterranean structural trap, whereas the results of the other indicate the possibility of the presence or absence of gas or oil. Since a geomicrobiological survey can be executed within a relatively short period of time, it could be used to locate anomalies as a screening tool. These anomalies could then be defined by any of the geophysical methods applicable in a given area. Thus one method could be used to strengthen the results or indications of the other. In addition, there are situations where presently established methods cannot be used. In these instances, geomicrobological methods should be of some assistance in locating such deposits.

The low and apparently decreasing probability of striking a producing horizon by existing methodology coupled with increasing drilling costs indicates a definite need for improving the exploration situation. A combination of prospecting methods based on different premises need improve the odds of wildcatting for oil only slightly to be of importance to the petroleum industry. The application of microbiological procedures to the problem of increasing the general effectiveness of scientific methodology in the location of oil and gas deposits merits serious consideration by the industry.

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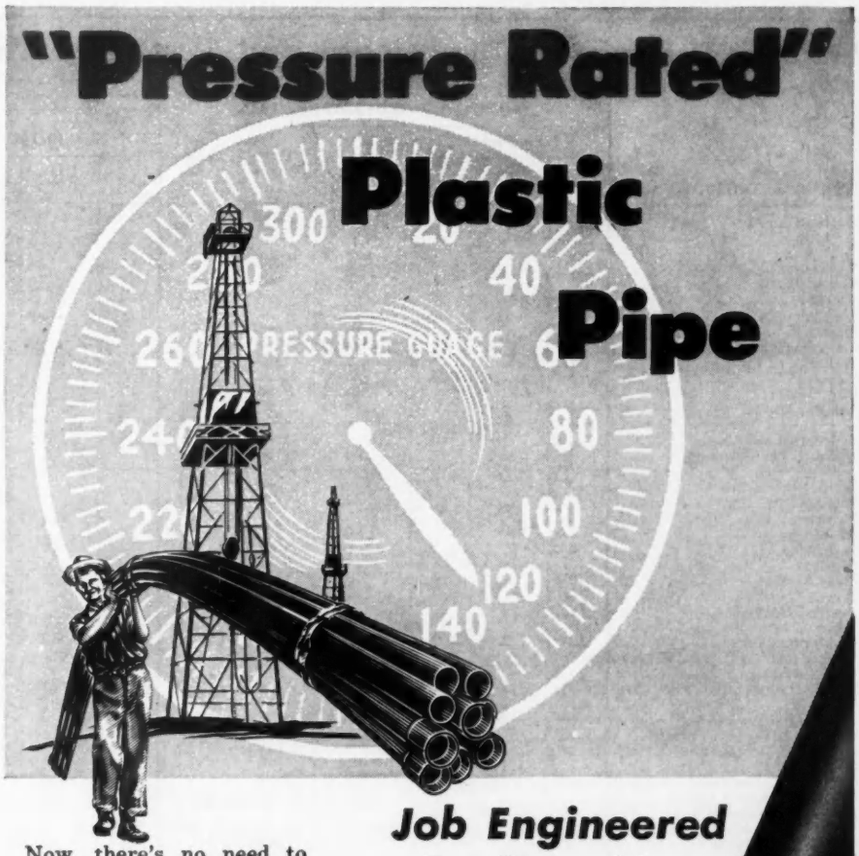

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Wildcat Drilling—In September and First Nine Months, 1955-1954

STATE or DISTRICT	MONTH OF SEPTEMBER, 1955						FIRST NINE MONTHS, 1955-1954								
	New Fields			Total Discoveries	Dry Wildcats	Total Wildcat Tests	New Fields			Total Discoveries		Dry Wildcats		Total Wildcat Tests	
	Oil	Distillate	Gas				Oil	Distillate	Gas	9 Mo. 1955	9 Mo. 1954	9 Mo. 1955	9 Mo. 1954	9 Mo. 1955	9 Mo. 1954
Alabama	..	..	..	....	2	2	..	....	....	....	....	34	49	34	49
Arizona	..	..	..	....	....	....	..	....	....	....	....	4	8	4	8
Arkansas	..	..	..	....	13	13	9	....	2	11	3	102	82	113	85
California	1	..	..	1	32	33	15	....	3	18	18	237	257	255	275
Colorado	1	..	1	2	55	57	28	1	19	48	52	557	386	605	438
Florida	..	..	..	....	3	3	..	....	....	....	1	23	24	23	25
Georgia	..	..	..	....	1	1	..	....	....	....	....	1	7	1	7
Idaho	..	..	..	....	....	....	..	....	1	1	....	2	1	3	1
Illinois	4	..	..	4	80	84	17	....	2	19	19	515	434	534	453
Indiana	2	..	..	2	12	14	11	....	1	12	11	135	196	147	207
Kansas	15	..	3	18	104	112	118	....	29	147	104	705	572	837	676
Kentucky	..	..	..	....	3	3	13	....	2	15	21	68	38	83	59
Louisiana	4	..	..	4	50	54	30	18	3	51	58	357	285	408	343
North Louisiana	..	..	..	....	18	18	6	2	....	8	8	136	113	144	121
South Louisiana	4	..	..	4	32	36	24	16	3	43	50	221	172	264	222
Michigan	..	..	..	....	18	18	2	....	1	3	9	151	158	154	167
Mississippi	1	..	..	1	19	20	7	1	....	8	5	126	124	134	129
Missouri	..	..	..	....	....	....	..	....	....	....	....	17	6	17	6
Montana	2	..	..	2	23	25	8	....	....	8	7	100	75	108	82
Nebraska	5	..	1	6	33	39	32	....	1	33	25	238	97	271	122
Nevada	..	..	..	....	....	....	..	....	....	....	1	4	9	4	10
New Mexico	2	..	6	8	9	17	22	2	27	51	44	104	126	155	170
North Carolina	..	..	..	....	....	....	..	....	....	....	....	....	....	....	....
North Dakota	..	..	..	....	15	15	3	....	....	3	1	48	78	51	79
Ohio	..	..	..	....	1	1	..	....	1	1	....	15	11	16	11
Oklahoma	12	1	3	16	70	86	76	10	15	101	105	482	534	583	639
Oregon	..	..	..	....	....	....	..	....	....	....	....	1	....	1	....
Pennsylvania	..	..	..	....	....	....	..	....	1	1	....	2	....	3	....
South Dakota	..	..	..	....	2	2	..	....	....	....	1	9	10	9	11
Texas	45	5	5	55	286	341	417	62	49	528	549	3,023	3,161	3,551	3,710
Dist. 1: South Central	2	..	..	2	32	34	19	4	1	24	29	287	230	311	259
Dist. 2: Middle Gulf	2	2	1	5	18	23	14	12	7	33	27	192	205	225	232
Dist. 3: Upper Gulf	1	1	..	2	20	22	15	16	7	38	34	285	305	323	339
Dist. 4: Lower Gulf-S.W.	2	1	..	3	26	29	25	16	6	47	43	300	276	347	319
Dist. 5: East Central	..	..	..	....	11	11	3	3	....	6	2	103	110	109	112
Dist. 6: Northeast	..	..	..	....	11	11	3	3	....	6	6	135	124	141	130
Dist. 7-B: North Central	13	..	2	15	45	60	125	1	10	136	156	661	690	797	846
Dist. 7-C: West Central	2	..	..	2	14	16	33	....	7	40	54	200	276	240	330
Dist. 8: West	6	..	..	6	33	39	62	....	1	63	79	333	306	396	385
Dist. 9: North	17	1	1	19	74	93	116	2	8	126	106	490	593	616	699
Dist. 10: Panhandle	..	..	1	1	2	3	..	....	2	9	37	2	46	46	59
Utah	1	..	1	2	14	16	7	....	4	11	4	54	27	65	31
West Virginia	..	..	..	....	1	1	..	....	7	7	....	13	1	20	1
Wyoming	..	..	..	....	18	18	18	....	2	20	55	131	153	151	208
Total United States	95	6	20	121	864	985	833	94	170	1097	1093	7,258	6,909	8,355	8,002

Wildcats Still Gaining

Lead over '54 boosted to 4.4 percent.

By CECIL W. SMITH, WORLD OIL Staff

THE NUMBER of wildcat wells completed during September was slightly greater than in August, and boosted the year's total to a 4.4 percent lead over last year's record operations. Despite the increase in exploration activity this year, the number of new discoveries barely topped the 1954 results.

September's wildcats numbered 985, an increase of 12 tests over August's 973, and 47 more than in September of last year. However, the month's activity was not as successful as in the previous periods. One hundred twenty-one discoveries were credited to September for a score of 12.3 percent of the total drilled, while 14.1 percent proved productive in the previous month, and 13.0 percent was the result in September, 1954.

In nine months, a total of 8355 wildcat tests was drilled to beat last year's record-breaking 8002 by 353 tests or 4.4 percent. However, these extra 353 wildcat wells resulted in only four additional discoveries. Since the first of the year, 1097 new fields were opened, and that was only four more than the 1093 discovered in the same period of 1954. This year's finds amounted to 13.1 percent of the total wildcats drilled, and a year earlier the score had been a somewhat better 13.7 percent.

Oil discoveries have been slightly more numerous this year than last, totalling 833 to 816, for a gain of 17 new oil fields, or 2.1 percent. However, the other types of discoveries have not quite measured up to last year's pace.

New natural gas fields amounted to 94 in the first nine months, while a year ago at the same time they had numbered 96, and gas-distillate discoveries added to 170 compared with 181 found last year.

Summary of Results of Wildcat Drilling

ITEM	Sept., 1955	Aug., 1955	NINE MONTHS January-September 1955	1954	Percent Diff.
New Field Discoveries:					
Oil	95	105	833	816	+ 2.1
Distillate	6	15	94	96	— 2.1
Gas	20	17	170	181	— 6.1
Total Discoveries	121	137	1097	1093	+ 0.4
Dry Wildcats	864	836	7258	6909	+ 5.1
Total Wildcat Tests	985	973	8355	8002	+ 4.4
Percent Productive	12.3	14.1	13.1	13.7	.....
Percent Dry	87.7	85.9	86.9	86.3	.....

What every contractor should know about . . .

Compressors for Air Drilling

Here's how to select the type, size and number of stages for compressor assemblies for various types of operations.

By JAMES T. MORRIS, Morris and Company, Houston
and ROBERT T. RAMSEY, The Cooper-Bessemer Company, Mt. Vernon, Ohio

LACK OF AGREEMENT among drilling contractors as to the air volumes and pressures that are required for air drilling has fostered a vague and doubtful attitude of the attributes of this type of drilling. A proper definition of these requirements would still leave the contractor without proved compressor assemblies to fulfill his needs. A more thorough understanding of compressor types and capacities is needed. Faced with this lack of necessary information many operators have decided to rent, rather than buy, compressors when they undertake air drilling.

Unfortunately, the portable compressors usually available for rent or lease are the wheel-mounted units used to provide air for paving breakers. The largest compressors of this type generally available are rated at 100-150 pounds per square inch and 600 cubic feet per minute. While these compressors are adequate for driving paving breakers or mining drills, they were designed for intermittent, rather than continuous operation. The general practice was to parallel 2 or 3 of these units and hope they would deliver enough air to do the job.

The results were fair as long as optimum air drilling conditions prevailed. However, they could not deliver enough pressure for air-mud drilling and could not handle more than token amounts of water. Many operators came away from their air drilling experience with a conviction that more adequate compressor systems are necessary if air drilling is to succeed.

The purpose here is to review the air pressure and volume requirements and to survey the equipment that might satisfy those requirements.

Pressure and Volume Requirements. A detailed study of the air pressures and volumes required for various rigs and drilling conditions will be made in a later article. However, it is widely recognized that a compressor system should meet three different sets of conditions.

1. **High volume, low pressure** for large holes, shallow to medium depths, and straight air drilling where water is not encountered. Typical conditions might be a volume of 3,300,000 cubic feet per day, measured at inlet conditions of 13 pounds per square inch absolute and 100° F. with a discharge pressure of 100 pounds per square inch gage.
2. **Medium volume, medium pressure** for handling water sands of low to moderate productivity and steady state air-mud drilling. A volume of 2 million cubic feet per day measured at 13 psia and 100° F. and a discharge pressure of 400 psig can serve to illustrate this condition.
3. **Low volume, high pressure** to unload water or mud columns. A volume of 1,400,000 cubic feet per day, measured at 13 psia and 100° F. with a discharge pressure of 1500 psig is one pressure-volume combination that might meet the requirements.

PART 1

It is immediately apparent that a successful air drilling compressor system must handle an unusually wide variety of pressure-volume combinations. If possible, the system should adapt itself to changing conditions automatically. The compressor system should be able to deliver air on a continuous basis with a minimum of repairs. In addition, it must be made up of compact, easily moved units.

Types of Compressors. There are four different types of compressors that might be considered for air drilling.

1. Centrifugal
2. Vane-type rotary
3. Automotive-type piston
4. Double-acting piston

Centrifugal compressors are generally considered medium-to-high volume, low-to-medium compression ratio, medium efficiency, high speed machines. While the volume requirements for air drilling lie in the lower range of practical centrifugal units, and the required compression ratios are relatively high, it is possible that centrifugals can replace positive displacement cylinders in certain pressure ranges.

The slightly lower efficiency of centrifugal compressors is a disadvantage, but light weight and small size are compensating advantages. It is possible that the speed-increasing gearboxes necessary to drive high speed

TABLE 1

Condensed Performance Specifications for a Piston-Type Air Drilling Compressor System

	CONDITION A†	CONDITION B	CONDITION C††
	Air Drilling of Surface Holes and Medium Depth Air Drilling Where Water is Not Encountered	Steady State Air-Mud Drilling or Air Drilling Through Water Zones of Low Productivity	Unloading Mud Column at Beginning of Air-Mud Drilling or Blowing Water From Hole
Volume cu.ft./day* (Actual air delivery under suction conditions)	3,300,000	2,000,000	1,400,000
Pressure, psig*	100	400	1,500
Number of stages in operation	2	3	4
Maximum horsepower input**	395	371	364
Maximum discharge temperature, degrees, F.***	321	357	363
Maximum pressure differential, psi	76.9	288.5	1067.7

A system of this size would be suitable for a rig in the 600—900 horsepower class, according to some experts. Larger rigs should be provided with larger systems and smaller slim hole rigs can drill effectively with less volume.

† If air-mud drilling is to be used exclusively the large volumes at 100 psi may not be needed.

†† If air-mud drilling is not to be used, a somewhat lower maximum pressure may be required.

* Suction conditions assumed to be 13 psia and 100° F.

** Horsepower input figures do not include drive losses or fan horsepower.

*** Maximum air temperatures are based on the assumption that intercoolers are capable of cooling air to 120° F. under the most severe conditions encountered.

centrifugals might partially nullify the weight and size advantages.

Because of the limited ratios available in practical centrifugal stages, more stages will be required. One rule-of-thumb indicates that four centrifugal stages will be required to repace one piston stage.

The writers believe that any system offered by a reputable manufacturer that uses centrifugal compressors for part or all the compression is worthy of careful study.

Vane-type rotary compressors have been used with some success for air drilling. Two-stage units have delivered pressures up to 125 psi in service and multi-stage units have delivered higher pressures in tests.

Vane-type compressors are available in sizes well adapted to the volume requirements of air drilling. Their moderate rotative speeds minimize the need for extreme ratio belts or gears. This type of compressors may turn out to be a good answer to the first two stages (and possibly the third stage) of compression. However, it is important to select units designed for continuous heavy-duty service.

Automotive-type piston compressors are widely used for small-to-medium volumes and for pressures up to around 300 psi. These relatively high speed machines are small in size and reasonably low in cost. Like all piston-type machines, they are very efficient.

In the sizes, types and pressure ratings available, automotive-type piston compressors are worthy of careful consideration. It is important to select units specifically designed for continuous service, however.

Double-acting piston compressors are offered in a wide range of sizes and in almost any pressure rating. This is the only class of compressor in which proved units are available to meet all the pressure and volume requirements of air and air-mud drilling. Cylinders are available in a wide range of sizes and pressure ratings. Unloading valves and clearance pockets can permit the system to operate over wide pressure and volume ranges. A complete selection of auxiliary equipment is available. Furthermore, nearly all these components were designed for continuous duty with a minimum of repairs, so they can be expected to give excellent service under the conditions encountered in air drilling. Accordingly, the remainder of this paper will be devoted to a study of systems made up of medium speed, double-acting piston compressor stages.

WHICH TYPE SHOULD BE CHOSEN, RIG POWER OR SELF POWER?

The answer to this question depends on what percentage of the time air can be used for drilling. If it can be used for even a reasonable percentage of the time, the use of rig power offers many advantages.

To begin with, any well-designed modern rig will have enough hoisting horsepower available to make fast round trips at full rated depth. Since most of this power would not be used by the rotary table or slush pumps during air or air-mud drilling, it would be available for driving the compressor system. This rig power appears to be sufficient to supply air in the quantities required for satisfactory air or air-mud drilling according to many authorities. When this is the case, the savings in weight and cost when using rig power are obvious.

However, there are some situations where self-powered compressor systems might be indicated. The following three conditions are representative of where self-powered systems might be used:

1. In the case of older rigs or slim hole rigs where sufficient rig power or suitable compounding and power take-offs are not available.
2. Where air drilling cannot be used enough to justify the investment and moving costs of rig powered systems.
3. Where air drilling is used only for completion, surface hole or other special conditions.

Certain service companies are already providing excellent self-contained compressor systems on a rental or service basis in some areas. These companies can also supply personnel skilled in air drilling and the operation of heavy duty compressors. Unless air can be used as a drilling medium for a reasonable percentage of the time, the employment of these service companies should be carefully considered.

Conditions for Compressor Rating. Volume requirements for air drilling (as given in most published material) are stated in terms of cubic feet per minute (or day) under standard inlet conditions of 14.7 psia and 68° F. This could be expressed in terms of weight by multiplying the volume by 0.0765. However, a great deal of air drilling can be expected to take pace at high altitudes and relatively high temperatures. Under these conditions, actual air delivery (by weight) of a compressor will fall far short of the delivery of the same machine under standard inlet conditions.

For example, if a compressor system is capable of delivering 100 pounds of air per minute under suction conditions of 14.7 psia (sea level) and 68° F., it will deliver only 79.2

pounds of air per minute when suction conditions are 12.35 psia and 100° F.

When other factors are approximately equal, the lifting power of an air stream will be roughly proportional to the square of the weight of air delivered. Under certain marginal conditions, this loss in actual air delivery could result in unsatisfactory drilling progress.

Since air compressor capacities are generally stated in terms of standard conditions, some conversion may be necessary. A reputable manufacturer should be consulted to determine the rating required if a compressor is to deliver a stated quantity of air at the highest altitude and the highest temperature likely to be encountered.

Horsepower Requirements. Actual power requirements depend on two things:—the air volume and pressure requirements and the overall compressor system efficiency. A detailed consideration of air volume and pressure requirements will be the subject of a later paper. For purposes of illustration however, the volumes and pressures given in the table in Figure 1 will be used.

To get horsepower requirements, certain assumptions are made. For example, it is assumed that the pressure drop through each intercooler can be held to 3 psi. It is also assumed that inlet conditions are 13 psia and 100° F. and the mechanical efficiency of the compressor is 95 percent. Under these conditions, the compressor system used in the example would require a maximum of 395 horsepower (not including intercooler fan horsepower and drive losses). A drilling contractor could safely install such a compressor system on rigs rated as low as 700 horsepower and be sure of having enough horsepower to drive the rotary table and the mud pumps (in the case of air-mud drilling).

In case one or more stages are replaced by centrifugal or vane-type rotary compressors, the horsepower requirements will be somewhat greater. This will result in slightly higher fuel consumption, but will probably not be enough to require a larger class of rig.

Number of Stages. In the case of piston compressors, the number of stages has a vital bearing on the cost and serviceability of the compressor. The system studied in this paper as an example used four stages of compression to go from 13 psia to 1500 psia. The same over-all ratio could be achieved in only three stages with a lighter, simpler, less expensive system. Why, then, should four stages be used?

The answer depends in part, on the flash point of the oil used for compressor cylinder lubrication. This flash point must always be higher than the highest air temperature if reliable, safe operation is to be achieved.

If air temperature exceeds the flash point of the oil, the oil tends to carbonize on discharge valves and seats, and on discharge manifolds and pipes. This carbon can hold the discharge valves open and seriously shorten valve life. Under certain conditions it could even raise discharge temperatures high enough to ignite the oil mist and cause a fire or explosion.

Experience has shown that, with compressor oils commonly used, the maximum discharge temperature should be held to 350° F. (or lower if possible). At least four stages are necessary if this condition is to be met.

With three stages, the compression ratio would have to be nearly 5 to 1 to reach 1500 psig discharge. With 120° F. suction air temperatures, maximum air temperatures would be around 465° F. and fire would be almost certain if conventional oils are used. Valve life would also be quite short.

The use of synthetic oils might reduce the hazard and allow the use of three stages. However, these oils are relatively expensive and their use for this purpose is not widespread. It is probably best to stay within more conventional discharge limitations at the present time.

How About Five Stages? For complete freedom from fire danger under continuous service at rated pressures, it is sometimes necessary to keep maximum temperatures below 300 degrees. This 300 degree maximum is recommended by some manufacturers for compressor systems called upon to operate continuously against rated pressures. To meet these standards, 5 stages would be required for the compressor system under consideration. Obviously a 5-stage system would be somewhat more complex than a 4-stage unit. It should, however, give slightly better service and have somewhat higher efficiency than a simpler system.

In deciding between a 4-stage and a 5-stage system, the safety and reliability of a 4-stage system should be the yardstick. Pressure-volume and service requirements for air drilling indicate that a 4-stage system would probably give good service without fire danger, particularly if paraffin base oils are used.

What About Air Cleaners? Air drilling compressors will be handling relatively clean air most of the time, but many will be required to operate in areas subject to dust storms. Also, in the case of straight air drilling without dust collectors, it is possible to encounter severe dust conditions if the compressor is located downwind from the flow line discharge.

For these reasons, it is important that a high grade, heavy duty air cleaner (probably of the oil bath type) be used. It is important that the cleaner be serviced regularly. In addition, it should be serviced immediately after any period of unusually dusty conditions.

Adequate Intercoolers Are Important. In many areas where air drilling might be used the average maximum summer temperature is 100° F. In some areas, notably Southwest Texas, average maximum temperature may reach 105° F. Furthermore, the water shortage in many of these areas prohibits the use of water for intercooling.

The necessity for keeping maximum air temperature as low as possible indicates the use of large capacity, high efficiency, radiator-type intercoolers. For example, in the 4-stage system used as an illustration in this paper, the intercoolers should be able to cool air from around 350° F. to 120° F. using 100° F., 13 psia air. Pressure drop should be kept to a maximum of three pounds per stage if possible.

When a compressor is being considered, the actual intercooler performance under the most severe conditions likely to be encountered should be specified. The risk of using systems that do not meet these specifications should be carefully considered.

Aftercooler Performance Should Be Checked. Aftercooler requirements are not quite as severe as in

Continued on Page 132

Mud Rate and Weight Logging Promises Gas Sand Evaluation

In the October issue, Parts 1 through 3 of this article, the author introduces the concept of continuously measuring the annular mud discharge rate and specific weight from rotary wells for the purpose of detecting gas sands and evaluating these sands as to gas saturation. Through the use of some simplifying assumptions, approximate theoretical relations were derived which describe the behavior of a column of gas-cut mud as it rises through the annulus and is discharged at the surface under the drive of a constant mud input rate to the drill pipe. A predictive type problem in discharge rates was solved for a particular well geometry and mud-to-gas volume ratio at bottom hole mixing conditions.

PART 4 Investigation of the effects of several factors which may limit the utility of discharge rates as a gas sand evaluation tool.

PART 5 The quantitative aspects of specific weight mud logging are derived and discussed.

PART 6 Summarizing discussion.

PART 4: The Effect of the Important Variables on Annular Discharge Rate

By JACK R. FRASER, Chief Engineer,
Texas Eastern Production Corporation, Houston

A. Depth of Sand:

In order to investigate the effect of depth of a gas sand on the annular discharge rate immediately before and immediately after breakthrough, Equations 22 and 30 were solved for a case where the depth varies between 2500 feet and 16,000 feet. For this analysis, we assume that $W_{go} = \frac{P_o}{32{,}086}$ pounds per cubic foot, and that $P_o = 2160 + HW_m$. The other constants used are those from the problem in Part 3 and are repeated, below, for convenience.

Sand Thickness = 10 ft.
Drilling Rate = 2 min./ft.
Annular Area, A = 0.5 sq./ft.
Q_m = 50 cf/min.
Z = 100 ft./min.
W_m = 80 lbs./cf
Gas Sand Saturation at P_o = 0.1 cf/lin. ft.
R = 1000 cf of mud/cf gas (at P_o)

The results of the computations are shown graphically on Figure 4, and as is intuitively expected, the deeper the gas sand, the greater will be the discharge to input rate differential, all other factors being the same. It is noted also, that the rate of discharge immediately after breakthrough is almost a linear function of depth and, therefore, of the original pressure of the mix, P_o.

B. Sand Thickness:

Varying the thickness of the gas sand has the effect of varying D and P_1 at breakthrough, and therefore, the F factor in Equation 22. It also serves to make $R + \frac{P_o}{P_1}$ a variable quantity in Equation 30, since P_1, at breakthrough is a function of the length and composition of the gas-cut mud plug.

Table 3 gives solutions of Equations 22 and 30 at the instant of breakthrough for an input rate to the drill pipe of 50 cubic feet of clean mud per minute. The constants used are the same as above, and the depth of the sand is included as a variable.

From Table 3, it may be concluded that the thickness of the gas sand has a very minor effect on the rates of discharge, Q_a and Q_b, at the instant of breakthrough. This is so because it is mainly the rate of expansion of the upper few feet of the gas-cut mud column at the instant of breakthrough which causes the surge in rate of discharge. The relatively slow expansion rate of the bottom 90 percent or more of the plug at the instant of break-

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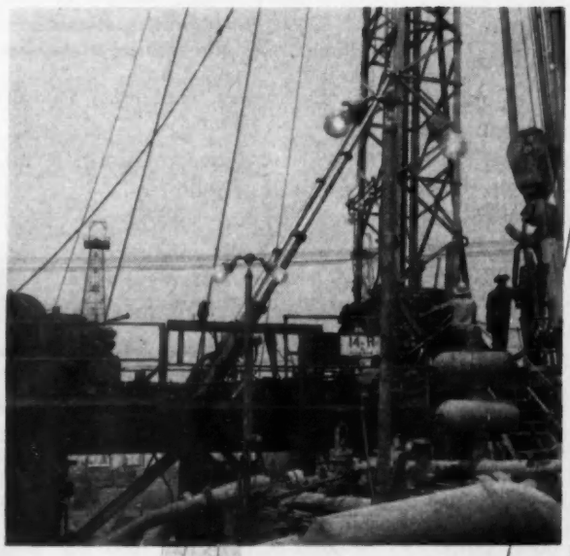
Photograph at right shows the location of driller's controls, mounted on hinged "Y" base of the mast. Extreme lower left of photo shows hydraulic controls for raising and telescoping mast operations.

Driller is located to have the best position possible for full view of work at all time.



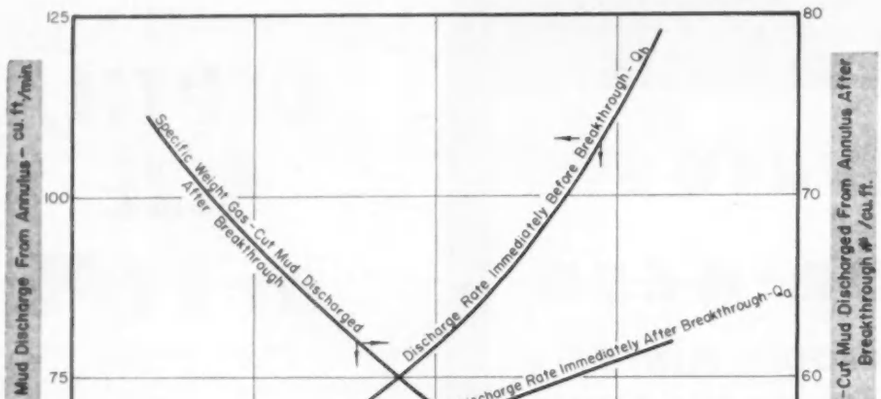


FIGURE 4

through comprises but a very small part of the total expansion rate for the entire plug. It would seem then, that there is no practical lower limit to the gas sand thickness which, of itself, would prevent a measurable rate surge from occurring. The duration of the surge is, of course, proportional to the length of the gas-cut mud column at the instant of breakthrough, and this, in turn, is a function of sand thickness, among other things. For the sands studied in Table 3 for example, the 10-foot gas sand would give rise to a 20+ minute surge, while the surge for the 2-foot sand would last only a little more than 4 minutes.

C. The Effect of the Magnitude of R:

The ratio R, cubic feet of mud per cubic feet of gas in the original gas-mud mixture, has a very marked effect on the calculated rates of discharge at the instant of breakthrough, Q_a and Q_b. Since the rate after breakthrough is much more lasting and of smaller magnitude than the rate immediately before breakthrough, it is the magnitude of the rate after breakthrough which is critical in determining the measureability and, therefore, the practicality of differential rate measurements for field use in evaluating gas sands penetrated by the bit. For this reason, the study of the effect of varying R on annular discharge rates was limited to the period immediately following the instant of breakthrough.

The meaning of R is more clearly understood through the following development:

From Part 2:

$$R = \frac{V_m}{V_{go}} \text{ (Eq. 3)}$$

And:

$$R = \frac{V_m^*}{V_{go}^*}$$

Where:

$V_m^* = Q_{mr}$ = Volume mud passing through bit per ft. of sand; cf/lin. ft.

$V_{go}^* = .7854\ d^2 f S_g$ = Volume gas drilled per ft. of sand; cf/lin. ft. (at P_o).

r = drilling rate; min./lin. ft. sand.

d = diameter of bit; ft.

f = fractional porosity of sand.

S_g = gas saturation of sand; fraction of pore volume at instant sand is cut.

Q_m = clean mud input to drill-pipe; cf/min.

From the above relations, R may be expressed as follows:

$$R = \frac{Q_m r}{.7854\ d^2 f S_g} \qquad (3a)$$

The difficult factor to evaluate on the right side of the above relationship is S_g, the gas saturation of a sand the instant it is cut loose from its bedding plane and commences its trip up-hole. (The whole purpose of this study is to find a means of determining S_g.) A recent paper by Ferguson and Klotz described an investigation of dynamic filtration beneath the bit in a rotary drilled well.[1] Their dynamic experiments were conducted with water sands having neither gaseous nor liquid hydrocarbon saturation, however, and the application of their analysis to our problem is obscure at best.

Core analysis data commonly show 40 percent to 70 percent total residual liquids saturation in commercial gas sands, leaving 60 percent to 30 percent of pore space as gas saturation. It is not certain how surface measured core saturations are related to saturations at the instant a core sample is cut at the bottom of a well, and even less certain how the laboratory measurements are related to in-situ virgin conditions. This same uncertainty is inherent in cuttings analysis saturation data. No attempt will be made here to add this writer's opinions on the subject to the conflicting ideas already found in abundance in the literature. It suffices to state that apparently very little is really known about gas saturation in commercial gas sand cuttings at the instant these cuttings are separated from the parent formation by a rotary bit.

Since we know so little of the gas saturation of gas sand cuttings at the instant they are drilled, let's assume that this saturation can normally vary between 90 percent and 10 percent of porosity and then some rough limiting values of R may be computed utilizing Equation 3. For example, on the Gulf Coast, the following limits

TABLE 3

ANNULAR DISCHARGE RATE AT BREAKTHROUGH
Cubic Feet/Minute

Depth Sand—Feet	10-Foot Sand		6-Foot Sand		2-Foot Sand	
	Q_b	Q_a	Q_b	Q_a	Q_b	Q_a
2,500	55.07	54.57	55.02	54.53	54.82	54.33
3,000	56.18	55.52	56.16	55.48	55.85	55.21
4,000	58.62	57.33	58.52	57.26	58.14	56.91
6,000	64.10	60.95	63.97	61.07	63.20	60.28
8,000	70.82	64.64	70.46	64.47	69.29	63.70
10,000	78.86	68.23	78.52	68.02	76.69	67.01
12,000	89.13	71.84	88.53	71.56	85.73	70.29
14,000	102.46	75.44	101.63	75.09	97.35	73.54
16,000	120.77	79.01	119.05	78.61	112.10	76.76

(This Data for Input Rate of 50 cf/Min.)

may be appropriate for gas pays:

Factor	Approximate Minimum	Approximate Maximum
Q_m	25 cf/min.	150 cf/min.
r	0.25 min./ft.	10 min./ft.
d	.5833 ft.	.8333 ft.
d^2	.3402 ft.^{2}	.6944 ft.^{2}
f	0.10	0.40
S_g	0.10	0.90

Then: $R_{max.} = \dfrac{150 \times 10}{.7854 \times .3402 \times 0.1 \times 0.1} = 562{,}000$

And, $R_{min.} = \dfrac{25 \times .25}{.7854 \times .6944 \times 0.4 \times 0.9} = 31.8$

It is apparent then, that R may vary by a factor of 18,000 or more. It is believed, however, that in most cases of practical interest, R will probably have values in the range 500 to 10,000, at least along the Gulf Coast gas province where penetration rates in pay are fairly high and gas pay sands are of fairly good quality.

By manipulation of the relations developed in Part 2, hereof, it may be established that at the instant of breakthrough:

$$P_1 = \frac{Q_m r h}{AR}(W_{go} + RW_m) + P_a$$

Where: h = sand thickness drilled; ft.

The above relation may be simplified by noting that W_{go} is of negligible magnitude relative to RW_m and may usually be ignored. Then:

$$P_1 \cong \frac{Q_m r h W_m}{A} + P_a$$

Now substituting the above relation in Equation 30 for P_1, we obtain for the instant immediately after breakthrough:

$$Q_a \cong \frac{Q_m\left(R + \dfrac{P_o}{P_a}\right)}{R + \dfrac{P_o}{\dfrac{Q_m r h W_m}{A} + P_a}} \quad ; \qquad (30a)$$

The above equation gives essentially the same values of Q_a as the original Equation 30. Equation 30a has been solved for the following case:

Q_m = 50 cf/min.
P_o = a variable depending on depth of sand. (Equal to $HW_m + P_a$)
P_a = 2160 lbs./sq. ft.
r = 2 min./ft.
h = 10 feet
W_m = 80 lbs./cf
A = 0.50 sq. ft.
R = variable from 500 to 10,000

The solutions are shown in graphic form on Figure 5. It is readily apparent that all other factors being the same, the deeper the gas sand, the greater R may be to yield a particular differential in rates between input to the drill-pipe and discharge from the annulus immediately after breakthrough. The curves suggest further that even fairly poor quality deep gas sands (below 10,000 ft.) may be detected and evaluated by differential rate measurements. Conversely, for shallow sands (above 5000 feet), the sand quality would have to be fairly good and circulation rates not unreasonably high, to assure detection and evaluation by rate measurements.

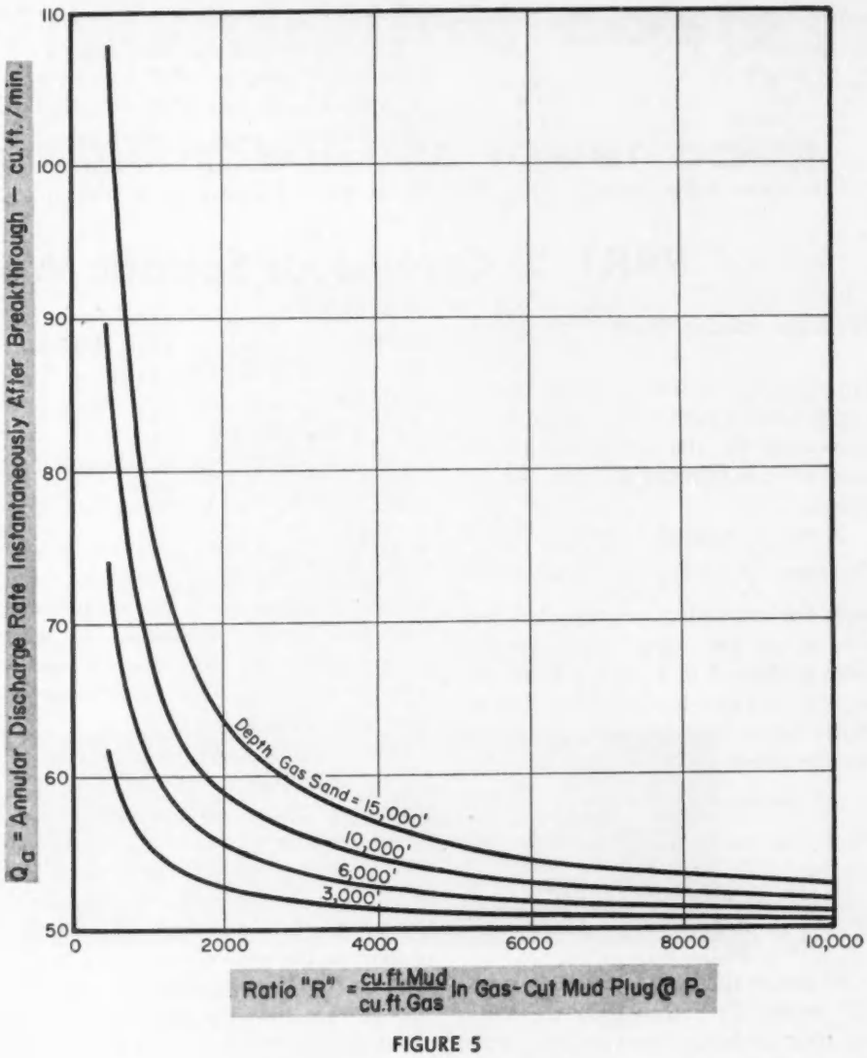


FIGURE 5

Equation 30a may be inverted and solved for R to give:

$$R = \frac{P_o}{Q_a - Q_m}\left[\frac{Q_m}{P_a} - \frac{Q_a}{ZrhW_m + P_a}\right]$$

Where: Q_a = Annular rate of discharge, immediately after breakthrough; cf/min.

If the above equation is applied to the data used in determining Figure 5, we can compute the maximum value that R may have to obtain a differential rate above some minimum at which it can be measured with consistent accuracy. For example, with an input rate of 50 cf/min., it may be possible to measure with consistent accuracy, a differential of 1 cf/min. We may then compute the maximum value that R may have to render the differential measurement possible. The results of such calculations are shown below:

Depth Sand	Approximate R max.
3,000 ft.	5,000
6,000 ft.	11,000
10,000 ft.	18,000
15,000 ft.	23,000

From this point we may proceed to inquire into the quality of a sand necessary for a particular depth to stay within the $R_{max.}$ shown in the preceding table. For this purpose, we may use Equation 3a, which is solved for a "sand quality factor," S_gf, as follows:

$$S_gf = \frac{Q_m r}{.7854\, d^2 R},$$

which becomes: $S_gf = \dfrac{188}{R}$

For
Q_m = 50 cf/min.
r = 2 min./ft.
d = 9⅞ in. = .8229 ft.
d^2 = .6772 ft.^{2}

Now, using the $R_{max.}$ found in the previous table, we may calculate the "sand quality factors" for a 10-foot sand at the depths for which $R_{max.}$ was computed. The table, page 128,

below) shows the results of such computations:

Depth	$S_g f$
3,000 ft.	.0376
6,000 ft.	.0171
10,000 ft.	.0104
15,000 ft.	.0082

The above table indicates that the product of S_g and f for a sand at 15,000 feet need be only about ¼ that for a sand at 3000 feet to give a measurable rate differential. For the 3000-foot sand, if the porosity is 30 percent, the gas saturation must be at least 12.5 percent of pore space at the instant the sand is cut. For 15 percent porosity sands at 10,000 feet, the gas saturation must be about 7 percent to give a discharge rate, immediately after breakthrough, of 51 cf/min., when the input rate to the drill-pipe is a steady 50 cf/min.

PART 5: Continuous Specific Weight Logging

From the relation $W_d = \frac{W_{go} + RW_m}{R + \frac{P_o}{P_a}}$, Equation 29, it would seem that R could be determined by continuously measuring the density of the gas-cut mud as it is discharged from the annulus.

It will be recalled, from Part 2, that the term $\frac{P_o}{P_a}$ in Equation 29 represents the expanded volume of a unit volume of gas when going up-hole from a pressure of P_o to a pressure P_a, at a constant temperature. Taking temperature into account and ignoring deviation from Boyle's Law, we may substitute $\frac{P_o T_a}{P_a T_o}$ for $\frac{P_o}{P_a}$ in Equation 29, solve the equation for R, and obtain:

$$R = \frac{\frac{W_d P_o T_a}{P_a T_o} - W_{go}}{W_m - W_d} \quad ; \qquad (29a)$$

Although the mud is normally some 20° to 50° F. cooler than the sand, the heat exchange between formation and mud at the bottom of the hole would probably not be sufficiently rapid to appreciably cool the gas in the cuttings prior to the envelopment of the cuttings by the mud. A reasonably accurate estimate of T_o in Equation 29a can be made, then, from normal geothermal gradient data for the area in which the well is being drilled.

The value of P_o, the pressure in the mud at dynamic bottom-hole conditions, may be calculated from hydraulic data such as that developed by Hughes Tool Company in their Bulletins 1-A, and 2-A, April and July, 1954, respectively.

Because of its small magnitude relative to $\frac{W_d P_o T_a}{P_a T_o}$ in Equation 29a, W_{go} may be estimated at some reasonable figure using P_o and T_o as determined above, together with an assumed gas gravity. Usually, however, W_{go} may be omitted from Equation 29a without introducing appreciable error in the calculated value of R.

Since W_m, the specific weight of the clean mud, may be obtained by spot checking the mud with a conventional density balance, the problem in applying Equation 29a to evaluate gas sands lies in the need to measure, probably continuously, the specific weight of the gas-cut mud at the discharge from the annulus. As stated in the introduction to this article, it is doubtful if W_d is ever accurately measured in field practice since a large part of the entrained gas escapes from the mud by the time a mud sample is caught, prepared, and weighed with conventional equipment. Despite this loss, mud weight reductions of 20 percent to 30 percent are not uncommonly observed with conventional mud balance equipment during periods when gas-cut mud is being discharged from the annulus. It seems likely, then, that the actual density of gas-cut mud is usually considerably lower than is indicated by spot-checks with a conventional mud balance.

From the foregoing discussion, it is apparent that to successfully apply Equation 29a to the problem of evaluating gas sands, an instrument is required which will provide a means of continuously measuring and recording the specific weight of the mud as it is discharged from the annulus. The annulus above the mud flow line must be sealed by a rotary head so that everything coming up the annulus is discharged through the flow line where representative samples may be continuously weighed under a slight pressure. There is no apparent reason why such an instrument cannot be developed and put into use; indeed, such an instrument might already exist which could be adapted to this use.

Once we have determined R from Equation 29a, we can calculate the "sand quality factor" as outlined in the preceding Part 4 of this paper, by inserting the proper values in the equation:

$$S_g f = \frac{Q_m r}{.7854\, d^2 R}$$

With the use of an assumed or measured porosity value, the gas saturation of the sand may then be computed.

PART 6: Summary and Discussion

The foregoing sections of this paper have outlined in some detail the approximate mathematical and physical relations involved in the utilization of either continuous rate of annular discharge data or continuous mud weight measurements in the problem of gas sand evaluation.

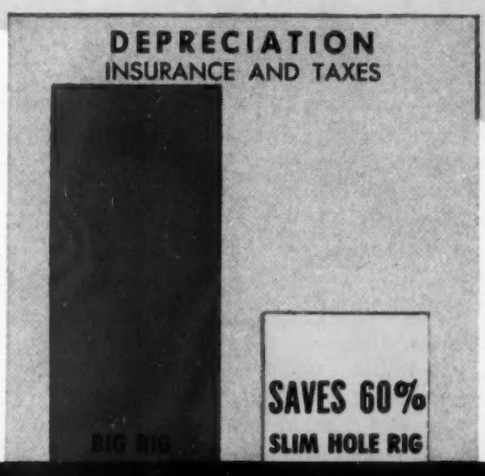
It should be emphasized, here, that in the predictive problem in rates (Part 3), the solution shown was only for the purpose of demonstrating the shape of the rate-time curve and arriving at the approximate rate values under a particular set of circumstances. Because of the assumptions used in their derivation, the rate-time relations must be regarded as approximate. The additional variables which will have to be dealt with mathematically to establish more exact relations are mainly the flowing temperature and pressure gradients in the mud rising in the annulus. It is believed, however, that the formulae developed in this paper will have considerable utility in helping to understand field-measured rate anomalies. This practical application is, of course, the inverse of the predictive problem, and all of the variables are automatically accounted for since we are measuring at the surface the integrated effects of all variables involved.

In applying rate measurements, the equipment required is a recording rate meter on the flow line from the annulus and a gas-tight rotating head above the flow line. By integrating

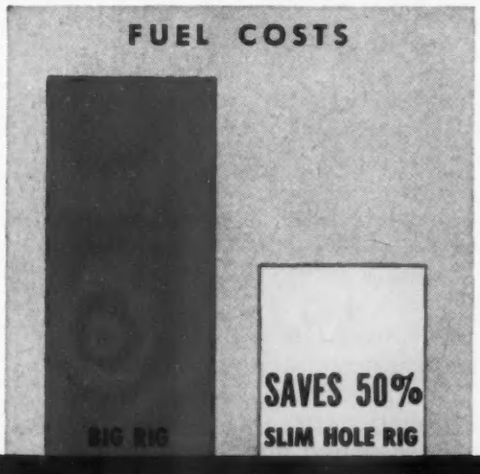
CAN CUT daily drilling costs . . .

less expensive equipment can lower costs

Smaller rigs require low initial investment, depreciation, insurance, taxes, and maintenance. Such rigs can be operated with 4 and sometimes 3 men—thus reflecting considerable saving in labor. Because of lower daily costs, considerable savings can be effected. As an example, if a "big" rig can drill a well in 10 days, a Slim Hole rig could take 23 days before drilling costs became equal.



Being lighter, smaller, and generally simpler, Slim Hole rigs usually cost considerably less than "big" rigs. Sometimes this cost differential is less than expected because some Slim Hole rigs are wheel-mounted, or self-powered, and often have special equipment to reduce rig-up time. In most instances, a Slim Hole contractor may anticipate a lower capital investment, lower depreciation, and insurance rates.



Fuel savings of 25% to 60% might be expected using Slim Hole rigs, depending on per cent load factor and pump requirements for the given area. Compound Slim Hole rigs rarely need more than half as much peak power as "big" rigs rated for same depth.

Slim Hole contractors report that one-third savings in repair costs might be expected when compared to the larger, more complex mechanism of "big" rigs. This saving depends on drilling conditions, the contractor and his personnel.

CARDWELL now has many rig combinations available for Slim Hole Drilling From this line of equipment, a contractor, operator, or workover contractor may select either compound or split rigs, either wheel-mounted or skid-mounted assemblies. He can choose a wide variety of drives, masts, engines, pumps, or air compressors. See your nearest Cardwell representative, or write Cardwell for complete information on Slim Hole rigs.

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mechanically for the total area under the discharge rate versus time curve following the instant of breakthrough, the total volume of the gas-cut mud plug may be determined at the measuring temperature and pressure. From drilling time and input mud rates, the volume of clean mud in the gas-cut mud plug may be computed and this subtracted from the total volume to give the volume of gas in the gas-cut mud plug. This gas volume, corrected to bottom-hole conditions of temperature and pressure, may be expressed as a fraction of the total gas sand bulk volume drilled or, together with a porosity estimate or measurement, may be expressed as a fractional gas saturation (percent of pore space).

In the application of continuous specific weight measurements, the equipment required in addition to the rotating head above the flow line, is a continuously recording mud weight meter. From the weight data taken at specific conditions of temperature and pressure, the ratio R, cf mud/cf gas at bottom-hole conditions, is computed. From this ratio, together with assumed or measured porosity values, the gas saturation of the sand may be computed.

Thus, from a theoretical standpoint at least, it appears that either rate or weight logging may be used independently of all other methods to evaluate the gas saturation of a sand at bottom-hole conditions. Since conventional mud logging equipment as presently used is sufficiently developed that gas in mud can be detected, it appears that the advantages of rate or weight logging lie in their quantitative possibilities.

Another point of practical interest should perhaps be mentioned again in this summary. It will be recalled by the reader that, in connection with the predictive problem in Part 3, the effect of the expanding and rising gas-cut mud column on bottom-hole pressure was computed and it was found that, for the case under consideration, the reduction in differential pressure across the bottom of the hole was negligible. Although the writer has not pursued this problem further analytically, taking into consideration flowing pressure gradient in the mud, it appears that drilled gas (gas expanding out of the pore spaces of formation cuttings only) is not ordinarily the blow-out hazard it is commonly believed to be. The exception to this is encountered, however, when it is necessary to drill with a very close balance between formation pressure and bottom-hole pressure in the mud column to prevent loss of circulation.

Finally, it has no doubt been noted by the reader that the concepts developed here have been discussed only in relation to gas sands. No serious thought has yet been given by the writer to the application of rate or weight data in the case of oil sand detection and evaluation, although it is probable that the concept might find some utility in this case, as well as in the case of gas sands, if there is considerable solution gas in the oil.

It is regrettable that the writer is unable to present some field data to either confirm or condemn his analysis but, to his knowledge, neither continuous rate nor weight logging has yet been undertaken with the proper equipment under favorable (or unfavorable) circumstances in the field. If the foregoing analysis results in having this idea thoroughly tested, this article will have served one of its principal purposes.

ERRATA

In the next-to-last paragraph, Page 143, Part 3, of this article (October, 1955, WORLD OIL), the first sentence should read, "The area under the curve in Figure 3, to the right of the instant of breakthrough, represents the total volume of the gas-cut mud plug . . ., etc.," omitting the phrase, "and above the input rate level." In Figure 2, Page 138, Part 2, the top dimension on the right side should read

$$\left(\text{“H} - Zt - \frac{P_2 - P_a}{W_m} \text{ft.”}\right)$$

The minus sign between P_2 and P_a was omitted in the original. In the summary list of equations at the end of Part 2, Page 140, replace

$$Q_b = \frac{dV_d}{\bar{dt}} \text{ by } Q_b = \frac{dV_d}{dt},$$

omitting the bar above the "t."

REFERENCE

[1] "Filtration From Mud During Drilling," Ferguson and Klotz, AIME, 1953.

ACKNOWLEDGMENTS

The writer is indebted to Vince Sikora, Atlantic Refining Company, and William Hurst, consulting petroleum engineer, for their valuable suggestions. He is especially indebted to Robert Rochon, Monarch Logging Company, who has demonstrated his confidence in the practical utility of the rate and weight logging concepts by commencing the design and construction of equipment to test these ideas in the field. The author also wishes to express his gratitude to the management of Texas Eastern Production Corporation for their generosity in allowing him time to prepare this work, and for their permission to publish it.

Compressors for Air Drilling

Continued from Page 121

the case of intercoolers. The maximum air temperature from the aftercooler is limited by the ability of the rotary hose to withstand heat and this temperature has not yet been firmly established in practice. However, some operators have encountered trouble when discharge temperatures have exceeded 200° F. and these troubles have disappeared when discharge temperatures were reduced. In general, it is well to make sure that the highest discharge temperature—even under the most severe conditions—be kept clearly below 200° F.

Moisture Traps Are Important. Even in semi-desert country, the compressor system can be expected to handle moist air on many occasions. Since it is well known that condensed moisture will accelerate ring and cylinder wear, it is necessary that good moisture traps be provided after each intercooler and the aftercooler. These traps may be either automatic or manual in operation but in either case certain precautions need be observed.

Manually operated traps must be drained regularly. It is essential that an operator set up a regular schedule for draining the traps and see that the schedule is observed.

Automatic traps are sensitive to the pressure of dirt and sludge so it is important that they be checked regularly to see that they are operating correctly.

Summary. Heavy-duty compressor components of proved design are now available from leading compressor manufacturers. These components can be assembled into systems that meet all the pressure and volume requirements of air and air-mud drilling. They can be expected to give reliable service over a long period of time.

However, certain precautions should be observed in judging specifications of compressor systems. If these precautions are observed, adequate systems will be assured.

Certain instructions should be followed in operating and maintaining these compressor systems. If these instructions are followed, long life and low overall cost will result.

Part 2 will appear in a future issue

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Classifying Drill Collars and Bottom Assemblies for Crooked Hole Studies

The mathematical approach to the crooked hole problem is proven correct for wells drilled in the Russell field of West Texas.

By STANLEY C. MOORE, Drilco Oil Tools, Midland,
and M. M. BRANTLY, Brantly Drilling Company, Midland

IN THE RUSSELL Devonian field of Gaines County, Texas, where deviation is the greatest obstacle to progress, the most important single factor in achieving high penetration rates is a properly designed drill collar assembly just above the bit. The work of Woods and Lubinski on the effect of drill collar size and stabilizer placement in deviated holes is the most practical guide for designing this assembly.

The first really organized approach to the crooked hole problem was the theoretical one made by Woods and Lubinski.[1, 2, 3, 4, 5] This work is considered an important contribution to the industry, not only because it seems to be proving a practical application of mathematics to the problem, but also because it has provided the first real basis for a logical approach to hole deviation problems. Although their completed work has only been released a few months, reactions are already beginning to appear, such as the very comprehensive study recently reported by Speer and Holliday.[6]

Woods and Lubinski make the following points:

1. The free part of the drill collar string immediately above the bit is a pendulum.
2. The more effective this pendulum is, the greater gravity pulls the bit toward vertical.
3. The larger the drill collars, the more effective they are as a pendulum.
4. A properly placed stabilizer increases the length, and therefore the effectiveness of the pendulum.
5. A reamer placed just above the bit reduces pendulum effect.
6. The greater the deviation angle, the more effective the pendulum becomes.

It is too early to attempt a complete evaluation of the practical possibilities of their theory, but a progress report is in order. In contemplating the approach that should be taken, many glowing accounts of the successful application of the theory were received. It was decided to choose a geologic area which presented the most consistent crooked hole problem, one which had been re-

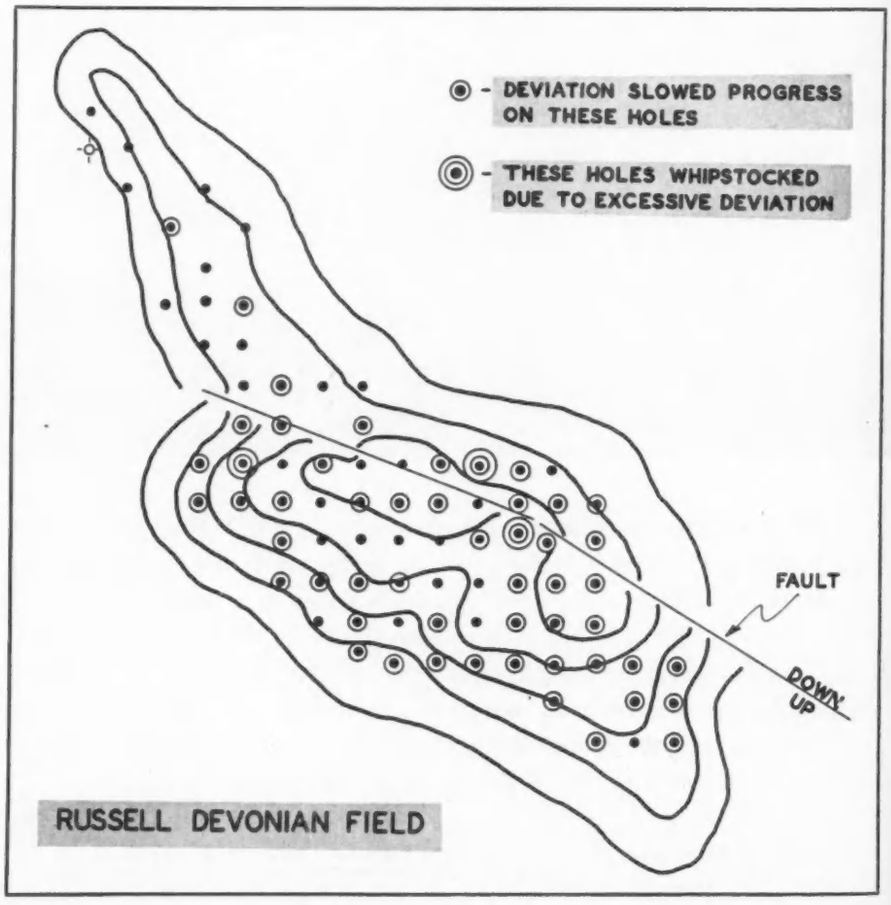

FIGURE 1

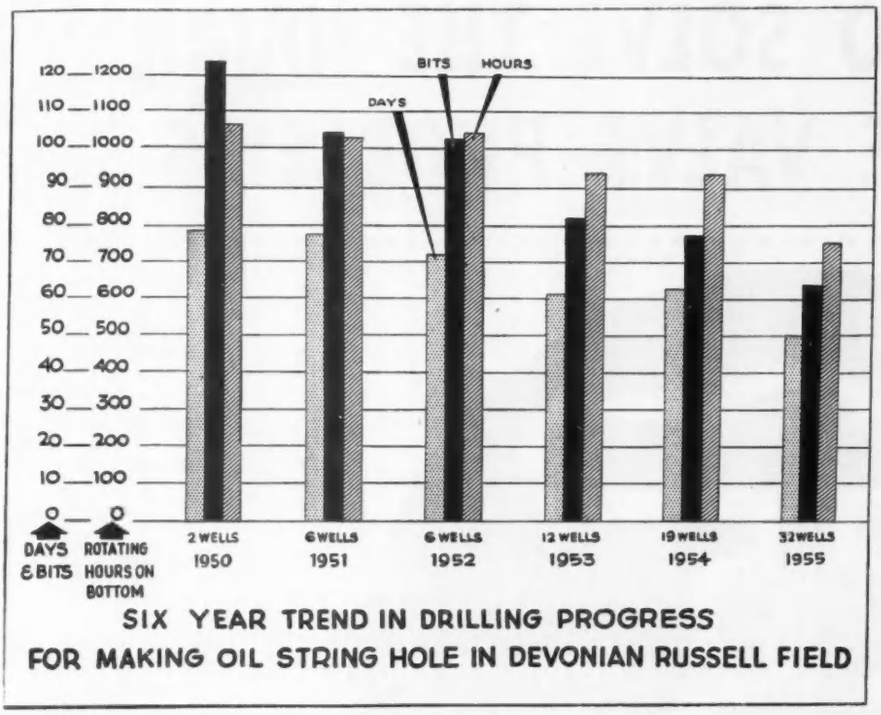

FIGURE 2

cently drilled, and to include in this report data from every hole drilled.

The Devonian wells in the Russell field in Gaines County, in the center of the Permian Basin were selected for study for several reasons. In the first place, progress was impeded in the drilling of 52 of the 82 holes completed to date. Even those that reported no trouble, in many cases, ran such light weight from start to finish that "fear of crooked hole" might be said to have impeded their progress.

Plotting 52 troublesome wells on the map, Figure 1, shows that there is no particular area which might be classified good or bad in this respect. When an operator spuds in, his chances are about the same regardless of locality on the structure. There is no safe "top of structure" area where formations are flat all the way down. Apparently this is due to the fact that the anticlinal structure dips away in both directions from the fault which bisects the field. Three operators unfortunately drilled into the fault and had their hole deviations increase abruptly.

Figure 2 graphically illustrates the six-year trend in days, bits, and on-bottom hours required to drill the oil string hole from 4500 feet to approximately 11,000 feet. Improvements were: 30 percent in days, 50 percent in bits and 31 percent in on-bottom rotating hours. The larger improvement in bits is attributed to better bits, the extensive use of tungsten-carbide insert types, and the more efficient utilization of bits.

This study is limited, because of inadequate information on the earlier holes, to the 51 wells drilled in 1954 and the first eight months of 1955. The wells were drilled by 18 different contractors or operators; by using data from all of them, the averages can be considered safe assumptions. A complete set of bit records on the 82 wells provided information on drilling time and bit performance. The data they included on deviation and bit weights was the best available, and complete enough in 1954 and 1955 for our study. Several of the earlier wells were not included in comparisons because casing strings were set at odd depths.

Although some information was available on bottom assemblies from the bit records, contractors were consulted for accurated descriptions of assemblies. The next step was to classify each drill collar assembly used for drilling these 51 wells in order to determine how each of the assemblies would rate on the charts prepared by Woods and Lubiniski for evaluating "pendulum effect."

TABLE 1
Classification of Drill Collar Sizes

	SIZE DRILL COLLAR		
	"Small"	"Medium"	"Large"
6¾" Hole....	4¾"	5¾"	6"
7⅞" Hole....	5¾"	6⅜"	7"
8¾" Hole....	6¼"	7"	7¾"

If it could be determined that those contractors who designed their bottom assemblies properly, suffered least from crooked hole difficulties, then certainly the procedure has merit. Accordingly, a system was set up for "rating" each bottom assembly. Figure 3 and Table 1 show how Woods and Lubinski charts were used to classify each assembly as to its effectiveness as a free "pendulum."

Only the size of the bottom two or three drill collars and the procedure for using a stabilizer were considered. Naturally, many cases were difficult to classify. If an assembly belonged in one class with a stabilizer and in the next class without a stabilizer—and the stabilizer was used only part of the time, or in an effective manner, they were classified somewhere between the two classes.

Table 1, in which drill collar sizes only are classified, was established to compare results between different hole sizes. The holes drilled were fairly well divided between 6¾, 7⅞, and 8¾-inch sizes.

Approximately 25 percent of the bottom assemblies could not be classified from the "pendulum standpoint" because reamers were run a considerable part of the time, or a "packed hole" assembly was used. The packed hole assembly had many variations, but in every case it was intended to hold the bit in a vertical path with little help from gravity or pendulum effect. These operations will be compared with the others.

After classifying the assemblies the really vital question of who had crooked hole trouble and who did not had to be decided. Although there were very few holes that went out to contract limits, some of the fastest holes drilled might be termed "crooked" in that the deviation reached 3 or 4 degrees. Furthermore, some of the slowest holes were relatively straight.

Those who came closest to solving the crooked hole problem in this area were those who were able to drill the

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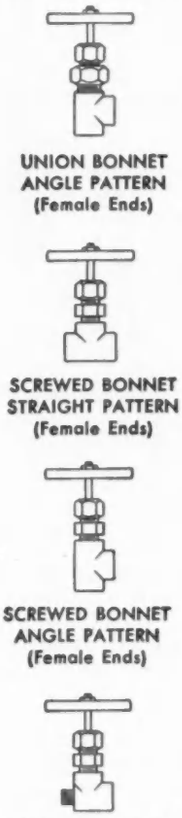

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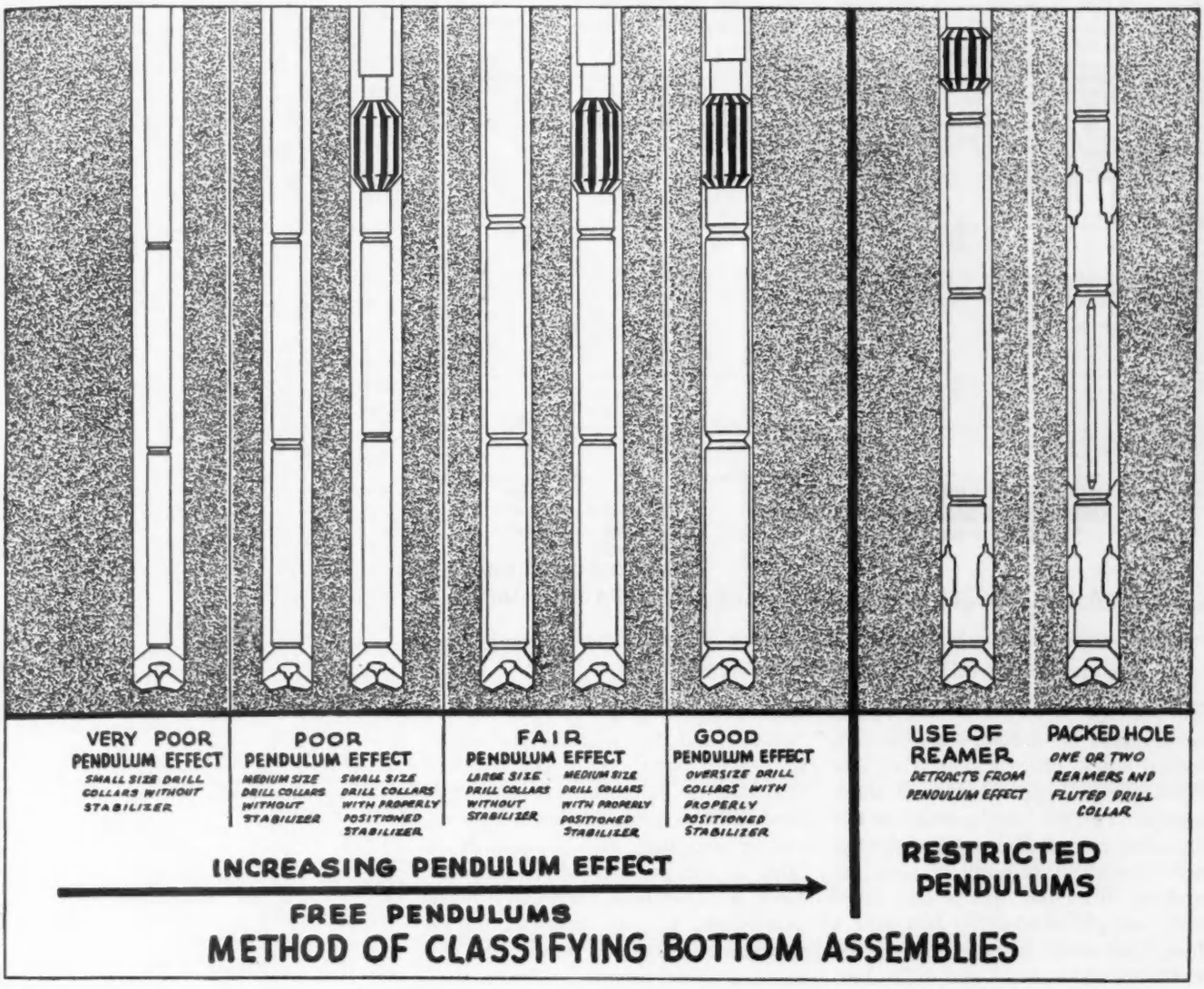
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GOOD PENDULUM EFFECT
OVERSIZE DRILL COLLARS WITH PROPERLY POSITIONED STABILIZER
USE OF REAMER
DETRACTS FROM PENDULUM EFFECT
PACKED HOLE
ONE OR TWO REAMERS AND FLUTED DRILL COLLAR
INCREASING PENDULUM EFFECT
RESTRICTED PENDULUMS
FREE PENDULUMS
METHOD OF CLASSIFYING BOTTOM ASSEMBLIES

FIGURE 3

fastest hole without exceeding contract deviation limits. Every operating man consulted agreed that the greatest obstacle to a fast hole in the Russell Devonian field is the danger of getting crooked. So the rate of penetration is considered the best measure of success in combating crooked hole.

A real effort has been made to insure the accuracy of the rate of penetration data and the method of classifying bottom assemblies. The most significant result of this study is the graphical analysis of drilling speed as related to type of bottom assemblies shown in Figure 4. Influencing factors such as mud programs and bit types varied but little. Hoisting and lost time did not effect the data. It is apparent that the type of bottom assembly has great bearing on the ability to achieve high rates of penetration.

Admittedly, heavier weights were run with the better assemblies. Lack of available weight did not cause the slow rates of penetration, because many of these holes were started with 22 to 30 drill collars in the string.

Referring again to Figure 4, it is evident that a well designed bottom assembly does not guarantee a fast hole; it merely increases the possibility of drilling one. On the other hand, a poor assembly seems to be a pretty good guarantee that a fast hole cannot be drilled.

The wells shown on the graph under the "Results Clouded by Excessive Use of Reamer" column were not included under the pendulum column because it was not readily apparent how to classify them. Their inclusion, however, would not have affected the appearance of the pendulum chart. Most of the reamers were used only part of the time, and then usually in conjunction with stabilizers.

The five holes drilled with "packed hole" technique are interesting. In each case a combination of reamers and fluted drill collars were used as indicated in Figure 3. Drilling rates were only average, and in three of the five instances the fluted collar was laid down before finishing the hole. They seem to have served their purpose by limiting the rate of deviation change very well.

Another approach to the evaluation of the various assemblies was to study the "deviation patterns" obtained by plotting deviation vs. depth. In Figure 5 we have plotted these for the six poorest rated pendulums, the six in the center of the pendulum chart,

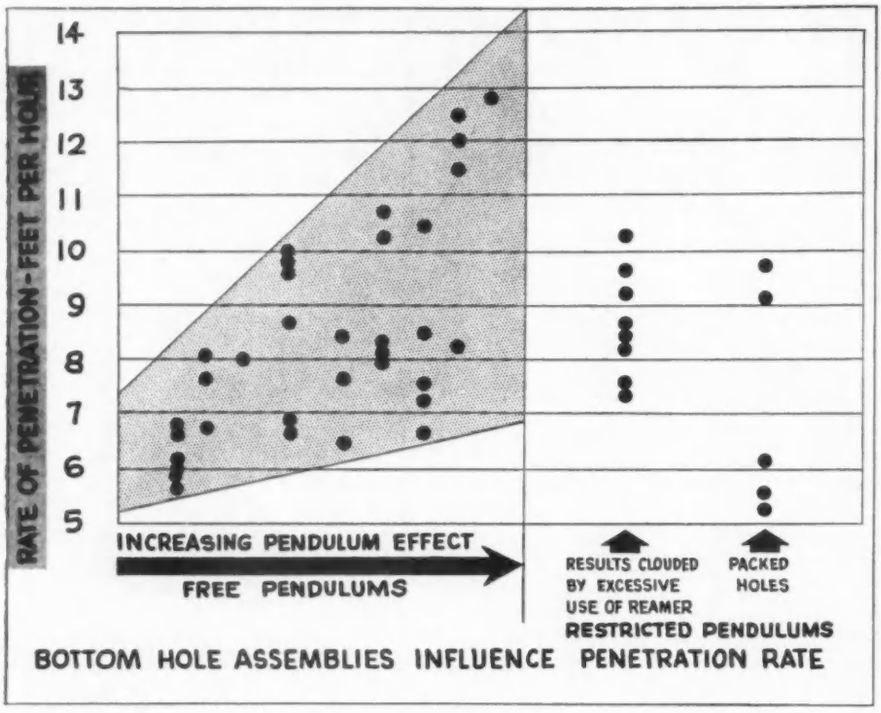


FIGURE 4

the six best pendulum, and the five packed holes. There is a striking difference in the appearance of these patterns. For the poor pendulum the deviation curve fluctuates violently, indicating the instability of such assemblies. In effect these are foreshortened pictures of the hole and a thoughtful study brings to mind the possibility of key-seats and difficulties in getting the casing down, and perhaps production difficulties at a later date.

The fair pendulums show some improvement in leveling off the violent fluctuations, and the patterns for the good pendulums seem quite smooth by comparison. The packed holes also produce relatively smooth patterns. Comparing all of the deviation patterns it is evident that the most desirable results were consistently obtained with the properly designed bottom assemblies.

Consider the actual assemblies that made up these poor, fair and good pendulums. Note that all six of the poor assemblies were used in 8¾-inch hole. This is logical, because had these same rigs been assigned 7⅞-inch holes to drill, the same drill collars would have been used and the assembly would have had a better rating. These 8¾-inch holes were all drilled with 6 and 6¼-inch outside diameter drill collars. Stabilizers were run only part of the time. These collars rated "small" and the pendulum would have been considered poor even if stabilizers had been correctly utilized. The average drilling weight recorded was only 26,000 pounds or 3000 pounds per inch of bit diameter. Even so, note how drastically deviation varied. In many cases the fluctuations in deviation were either the cause or effect of equally drastic fluctuations in drilling weight. The average drilling rate for these holes was 6.0 feet per hour.

One of the patterns under "fair pendulums" is for 8¾-inch hole, which deviated slightly beyond 5°. Records indicate that medium size drill collars, 7-inch OD, were used on bottom, and stabilizers were also used. A reamer was in use just above the bit when the hole went out beyond 5°. Even so, the rate of peneration was higher than for the six holes drilled with 6-inch and 6¼-inch OD drill collars.

Operators were able to use an average of 4200 pounds of weight per inch of bit diameter when employing the "fair assemblies," and the average drilling rate achieved was 8.2 feet per hour.

Assemblies classified as good in the 7⅞-inch holes used 6¾-inch or 7-inch OD drill collars on bottom, ran a stabilizer 60 feet above the bit, and used a reamer very little of the time. With these properly designed assemblies average weight employed was 5200 pounds per inch of bit diameter.

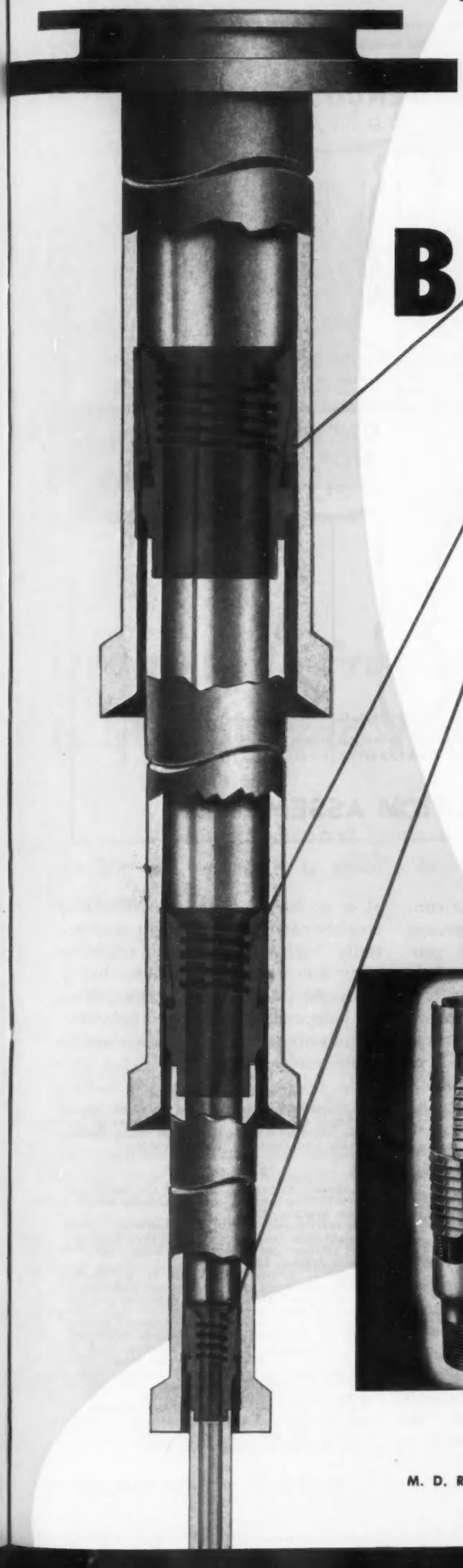
The fastest hole in the group was made with 7-inch OD drill collars on 7⅞-inch bits with a stabilizer at 60 feet. This was the only hole in which clear water was used to 10,700 feet. The usual practice is to mud up at about 9200 feet. However, a study of the progress of this hole to 9200 feet indicates that it would have been among the three fastest anyway. Drilling weight averaged 50,000 pounds, and sometimes 60,000 pounds. The average weight per inch of bit diameter was 6400 pounds. Penetration rate was 12.8 feet per hour.

It is significant that the six fastest holes followed the recommendations of Woods and Lubinski fairly well. On two of the holes the stabilizers were initially placed 30 feet above the bit and then moved up to 60 feet when the hole went beyond 2°. This means that the theory was employed to increase pendulum effect when it was needed.

There is still disagreement as to the proper stabilizer position. Woods and Lubinski's theoretical approach indicates that it is extremely critical. The recent work of Speer and Holliday in California indicates that relatively good results can be obtained within wide intervals, sometimes ranging from 45 feet to 110 feet between the bit and the first stabilizer. Of course there may be some fundamental difference between California formations drilled at 300 revolutions per minute rotary speeds and the corresponding factors in the Russell field in West Texas. Here the formations are much harder and the rotary speeds are only 60 to 75 rpm.

The authors agree with Woods and Lubinski, that for practical consideration the stabilizer should be placed approximately 10 percent closer to the bit than the calculated ideal position. But they also feel that almost as much benefit can be gained with the stabilizer as much as 20 percent closer than the ideal position. This reasoning is based on the fact that a stabilizer fixes the point at which the top of the pendulum rests against the wall of the hole. Without the stabilizer this point varies widely as the wall is neither a true or perfect cylinder.

Most of the calculated positions for placement of stabilizers in drill collar strings used in the Russell field range from 60 feet to 80 feet above the bit,



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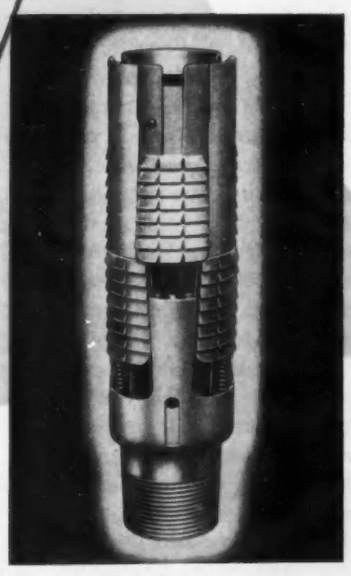

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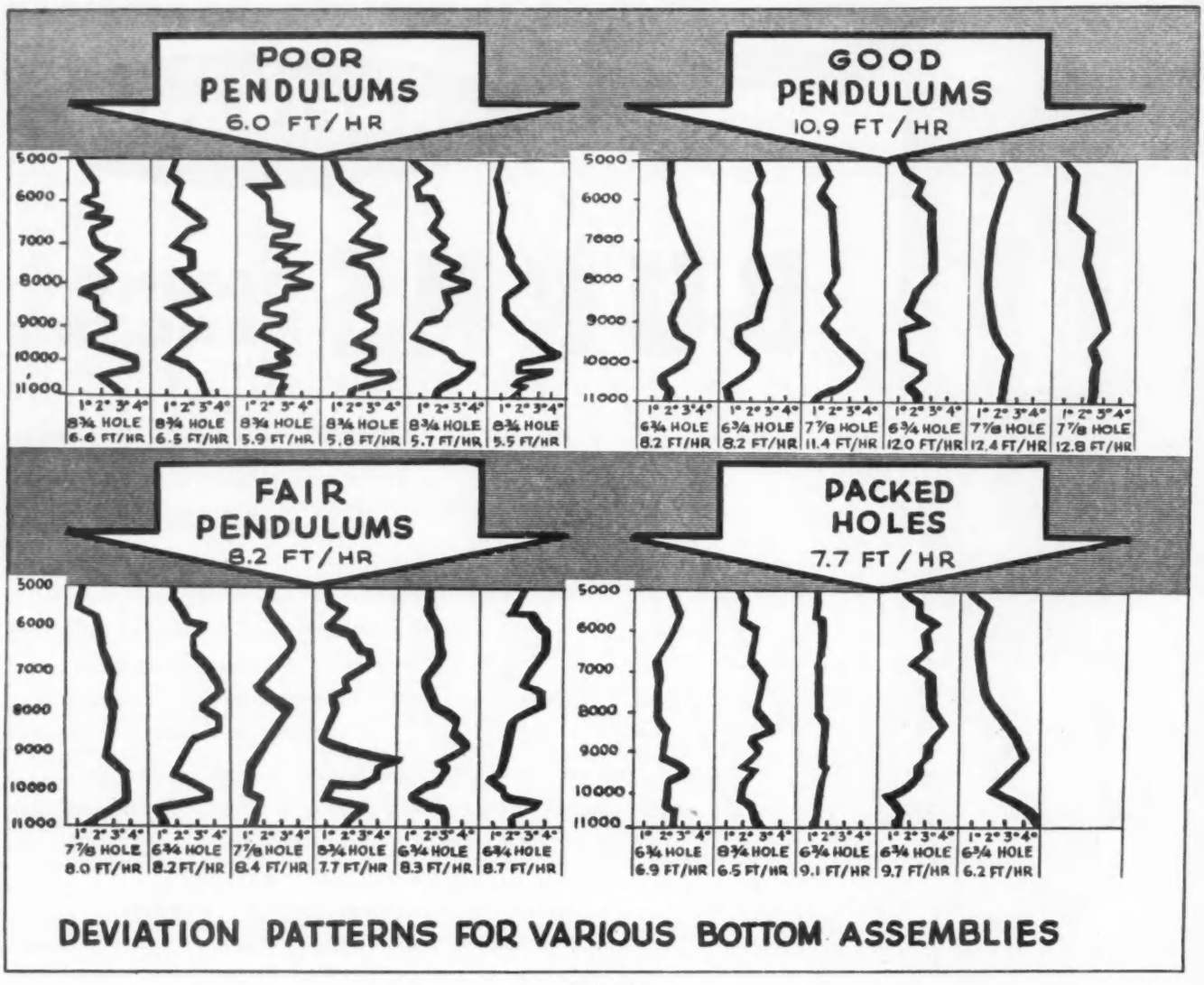

FIGURE 5

and for practical considerations is usually placed 60 feet above the bit. One operator drilled two wells using subs to place the stabilizer at exactly the ideal position and did not do as well as on the previous and following wells where the bottom stabilizer stayed at 60 feet from the bit.

The findings in this report substantiate the proposition that, where deviation is the limiting factor, twice as much weight can be run in 8¾-inch hole with 7¾-inch OD drill collars on the bottom as can be run using 6-inch OD drill collars on bottom. Twice as much weight may not be as much as the operator may wish to run. For example, an increase from 10,000 pounds to 20,000 pounds, where 50,000 pounds would be more desirable.

Disappointments in attempting to use the new approach for crooked hole drilling usually arise from: exceeding the theoretical capacity of the tools to drill straight, failure to consider drill collar size, and improper stabilizer placement. As work progresses on the design of bottom hole assemblies, some standard procedure for appraisal or rating of such assemblies may be desirable. All too often an operator will use a combination of drill collars, stabilizers and reamers which he thinks is good, but actually is not.

In this study of the data from the Russell field it was noted that higher penetration rates were often attained with these better stabilized bottom assemblies, at the same recorded weights. This possibility has often been advanced where very heavy weights are used. The theory is that the bit can be expected to perform better if it rotates about a straight and uniform axis. A six inch drill collar slapping the wall of an 8¾-inch hole, 15 feet above the bit, causes alternate cones to advance as much as ⅛ of an inch ahead of the others and possibly carry all the weight momentarily. Such "sloppy" action might be very harmful to bits under heavy loads. An investigation of this behavior independent of crooked hole considerations may produce very worthwhile results.

ACKNOWLEDGMENT

This article was presented at the 15th Annual Meeting of the AAODC in Houston, Texas on September 28, 1955 under the title of "How Drilling Practices and Geology Affect Deviation."

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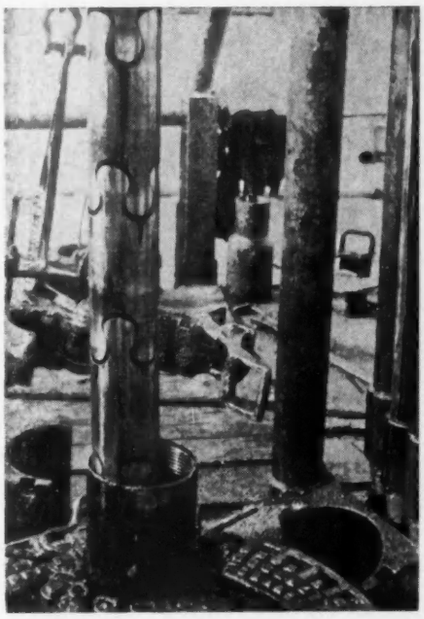
Flexible drill collar is pulled up into derrick. Note flexibility of collar.



Flexible drill collar being run into the hole, preparatory to drilling a drain hole.

Drain-Hole Fracturing Is Stimulating Wells

Results secured from drain-hole fracturing is causing the operator to take a second look at marginal locations.

By **GILBERT M. WILSON,** World Oil Staff

Formation fracturing through drain holes, relatively new technique in which fracturing is combined with the drilling of multiple drain holes in a producing formation, is showing excellent promise of being still another forward step in well stimulation. Already used with success in a very tight chalk formation in Louisiana, the technique increases recovery resulting from multiple drain hole drilling, itself a relatively recent practice in that particular field.

Factual data accumulated by the industry in recent years pertaining to fracturing and acidizing have proved the merit of these techniques as a stimulus to oil production. Until recently, the only known limitation in gaining even better results is that fracturing and acidizing have been limited in application to a relatively small diameter vertical well bore within the producing formation. The limitation of contact area is second in importance to the lack of directed application.

Under high pressure, the fracturing material or acid naturally will seek the area of least resistance and/or the more permeable areas of the formation. The point of least resistance in some cases might be the cementing point around the casing shoe. In other instances where the matrix is of very low permeability, and the formation contains vertical fractures, the area contacted in the vertical well bore is so limited that the higher injection pressures used for fracturing will not always allow a breakthrough to connect the existing fractures. The resulting increases in production are very slight.

The technique of drain hole drilling has been increasing fairly rapidly during the past few years in semi-depleted formations. For new completions this technique has shown evidence of being particularly applicable to areas where tight or lenticular sands, limestones, low pressure formations, and low gravity oil sands are encountered. Increases resulting from drain hole drilling have often converted marginal wells to paying producers, with daily production rates not uncommonly increasing from 100 to 400 percent.

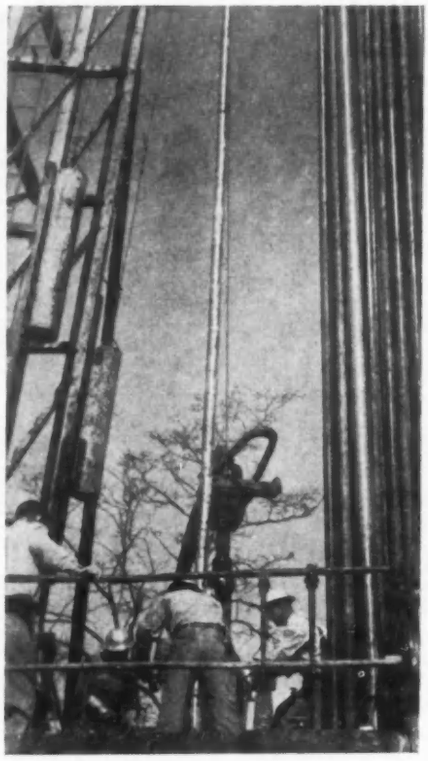
Higher Angle Whipstock Cuts Milling Time. Tools and techniques recently developed facilitate and speed up the milling of windows in casing and the whipstocking into the formation at a relatively high angle. This reduces the cost of drilling drain holes and improves the pay-out of many remedial jobs. A normal whipstock might go off at an angle of from 1 to 3 degrees, resulting in a window of from 15 to 18 feet in length. The newer technique permits milling at an angle of from 10 to 14 degrees, with a consequently shortened window of only 2 to 2½ feet in length. This higher angle of approach and correspondingly shortened window is responsible for the much lower time required for "windowing" operations. A description of the tools involved, drilling operations, and general results obtained in drilling of conventional drain hole completed wells, have been discussed in another article.[1]

Combining the already proven merits of fracturing (and/or acidizing) in many types of formations with drain hole drilling, multiplies the beneficial effect derived from either one when used separately. The case mentioned above, wherein drain holes were fractured to yield very favorable results, was in the Annona Chalk zone of the Pine Island field, a multiple-pay field located principally in northwestern Louisiana but partially overlapping into Harrison County, Texas. The Annona Chalk is one of the field's upper zones, is found at an average depth of about 1400 feet. It has been noted for its very low permeability, from ½ to 1 milidarcy, with an aver-

age porosity of 25 to 28 percent. The section usually is divided into three intervals; the Upper, with a thickness of about 70 feet; the Middle, of about 40 feet; and the Lower, of about 40 feet. Conventionally completed wells have a rapid decline, and usually level out at less than 100 barrels per day. The desirable 40° API gravity of the crude, the high gasoline content, and the fairly easy drilling, combine to make this zone a desirable objective with a fair payout time.

Longer Flowing Life. Early in 1953 operators drilling the Chalk wells started fracturing their wells with from 10,000 to 30,000 pounds of round sand, transported by either a heavy crude oil, or a refined residual fuel. One, two, or in many cases, all three zones of the Chalk were fractured. Noting the generally beneficial results being obtained, with flatter decline curves and longer flowing life of some wells, some operators started drain hole drilling their pay section to obtain still better results. This operation varied according to the ideas of the individual operator, and at first consisted of drilling three 50-foot drain holes into each of the two lower zones. Recently, however, a single 75-foot drain hole was drilled into each of the lower zones, or possibly the lowest zone and the upper zone, whichever zones appeared to be the most favorable. The reason for the shift to fewer drain holes was that when several drain holes were drilled into a comparatively thin zone from approximately the same level, there was no positive assurance, when the hole was fractured that each of the drain holes received its share of the fracturing treatment.

Rock Bit for Milling Alloy Sections. When it is known in advance at what depths drain holes will be drilled, sections of aluminum alloy casing are placed in the casing string. These alloy sections permit more economical window milling with only a conventional rock bit, instead of a mill, thus reducing window cutting costs. If possible, depending upon the thickness of the particular zone and the distance out into the formation that a drain hole will be drilled, the windows are cut at points which are sufficiently far apart so that they can be separated with a packer when fracturing. This spacing of drain hole windows thus assures that each hole can be treated as an individual well,



Crew readies flexible drill collar preparatory to milling out window and drilling drain hole out into formation.

with sand and fluid volumes being calculated more precisely and with assurance that each hole receives a treatment equivalent to that given a vertical hole.

Comparative production figures usually are hard to obtain as such data often are held confidential. However, some rough comparisons can be drawn from scattered figures obtained at various points in the field. With drain hole drilling and fracturing, a typical completion after one year often shows a sustained rate of production which varies from 50 to 100 percent more than that for wells conventionally completed by fracturing only.

It is difficult to draw accurate comparisons as there are wide variations in porosity and permeability. Also, one well may have one zone open to production and its offset might have two or three zones open.

In one comparison on a 15-well lease, 14 of the wells were drilled over a six-month period and completed with drain holes and fracturing. Typical completion in these 14 wells was to set pipe through the upper zone and complete barefoot in the two lower zones. Drain holes were drilled and fractured in the two lower zones and the upper zone peforated and fractured. The other, older well on this lease was not drain-hole drilled, but was completed by setting pipe through the upper zone and leaving the two lower zones open. The well was fractured open hole with 40,000 pounds of sand in the lower two zones; the upper zone was perforated and fractured with the drain-hole drilled wells were fractured with 20,000 pounds of sand in each zone. After six months, the average daily rate of production of the 14 new wells was 100 percent higher than the well which was not drain-hole drilled.

Fractured Drain Holes Show Rapid Payout. In some instances, where a conventionally drilled well may flow for a period of 10 days before being placed on the pump, nearby wells that were drain-hole drilled and fractured might flow three times as long. In one case, a well that was drain-hole drilled and fractured in two zones of the Chalk, was completed flowing, and at the end of what is considered the normal flowing time, the well continued to flow at a rate of 80 barrels per day. More than 30 of the 40-odd wells completed by this new technique in the Chalk zone have flowed about three times as long as the "normal" flowing life of conventionally-completed wells. One new well, after eight months, was pumping at about double the seven barrels per day rate at which many single vertical bore fractured wells level off after the rapid decline of the initial production. In some cases, the additional flush production obtained during the initial flowing life has paid for the drain hole drilling and fracturing job.

Favorable response to the drain hole fracturing treatment has caused some operators to take a second look at heretofore considered edge locations where permeability pinch-outs previously had more or less defined the productive limits of the area.

The Pine Island example is among the first in which drain hole fracturing techniques have been applied. Operators in other problem areas where tight formations such as dolomites, limestones and dense sandstones have produced slow returns, are considering use of the new technique. These areas include the Permian Basin and certain Rocky Mountain regions.

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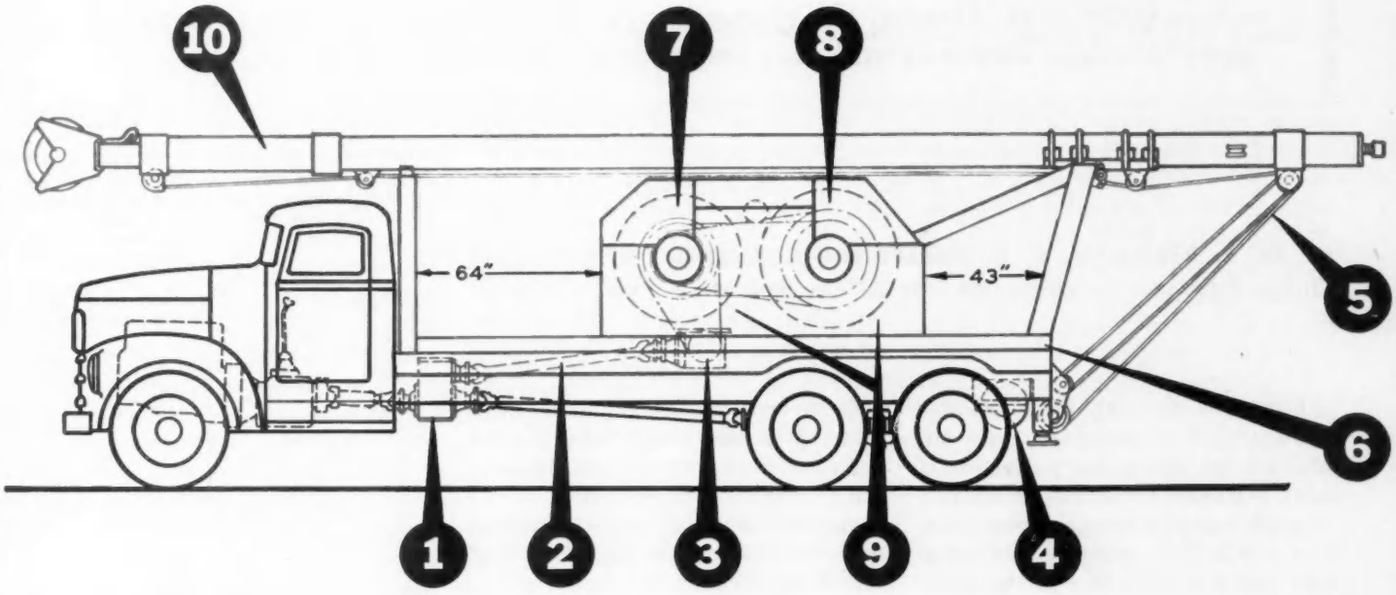

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CMHEC ... NEW OIL WELL CEMENT BLEND ... DE

While the drilling fluid scientist has refined mud filtrate characteristics to a point where dust can all but be blown from a pit surface, the cement chemist continues the drive to reduce slurry water loss factors to a comparable level. Herein, the discussion of those filtrate advantages gained from blending chemical and clay constituents with cement, is finalized.

By W. E. BERGMAN, J. R. HURLEY and F. J. SHELL,
Phillips Petroleum Company, Research Division, Bartlesville

FUNCTION OF THE carboxymethyl hydroxyethyl cellulose: As with the neat cement, the primary function of the CMHEC is for water-loss control. In each type of system the concentration of CMHEC must be selected to give the desired control of the filtration rate. The effect of the concentration of CMHEC upon the water-loss value of slurries prepared with Class A cement admixed with 20 and 40 percent DE is illustrated in Table 4. On the basis of these and other results 1.0 percent CMHEC was selected as a suitable concentration for the 20 percent DE system and 1.5 percent for the 40 percent system. These concentrations give initial water-loss values less than 20 ml. The water-loss control is not appreciably changed by moderate variation in the water-to-cement ratio. This is illustrated in Table 5 which also presents data showing the effect of aging at 180° F. upon the water-loss of the slurries. The increase in water-loss after aging may be attributed at least in part to changes in properties of the slurry as the cement thickens and to the effect of temperature upon the filtration rate. On the basis of these results as well as tests made on slurries aged under pressure at high temperatures, good water-loss control is maintained until the slurry becomes thick.

Another factor of importance with water-loss control is the degree of slurry agitation. It is evident that a definite period of time and agitation is required in order to disperse the CMHEC in the slurry. In general, the 35 second mixing period in the blendor (API Code 10A) does not produce maximum effectiveness of the CMHEC for initial water-loss control, but near maximum effectiveness is achieved in about 60 seconds. With less vigorous agitation, such as with the kitchen type mixer (API Code 10A), the time required is on the order of 2 to 5 minutes. In terms of field practice this implies that a low water-loss is not developed simply by jet mixing but will develop as the cement is pumped. A field test established that a low water-loss was achieved by the time the cement left the pumps of the cementing truck.

TABLE 4—The Effect of the Concentration of CMHEC Upon the Water-Loss of the 20 and 40 Percent DE Systems

CMHEC, Percent	Water-Loss, ml/30 Min. Initial	After 1 Hr. at 180 F.
A. 20 percent DE system with 120 percent water		
0.3	400	530
0.5	33	400
0.7	18	120
1.0	13	30
1.5	7	10
B. 40 percent DE system with 230 percent water		
1.0	31	100
1.5	17	40
2.0	12	28

TABLE 5—The Filtration Rate of the 20 and 40 Percent DE Systems as a Function of Percent Water and Silicate

Water, Percent	Silicate, Percent	WATER-LOSS, ml/30 Min.* Initial	Aged 1 Hour	Aged 2 Hours
PART A. 20 PERCENT DE SYSTEM				
110	0	11	27	45
110	1	..	..	25
110	3	..	..	22
110	5	15	..	101†
140	0	14	19	36
140	1	..	..	23
140	3	..	..	23
140	5	15	..	101†
PART B. 40 PERCENT DE SYSTEM				
180	0	15	..	33
180	3	15	..	25
180	5	15	..	110
220	0	18	24	27
220	3	18	22	27
220	5	18	16	27
220	7	16	25	..†
220	10	11	..†	..
260	0	20	..	33
260	3	21	..	26
260	5	..	..	26
260	7	16	25	..
260	10	22	26	..

* Initial values determined at room temperature. For the other tests the slurries were aged at 180° F. for one or two hours as stated in the procedure.

† For these tests the slurry had thickened so that the filtration rate could not be determined or the value obtained becomes high.

PART 2

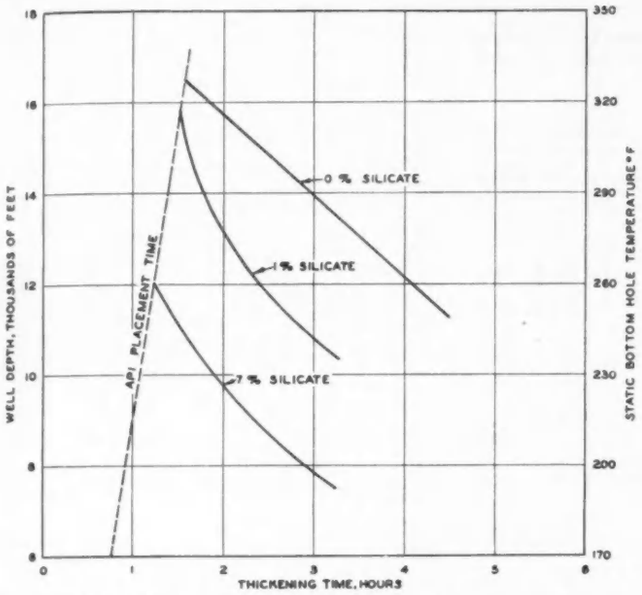

FIGURE 4—Thickening time for the 20 percent DE System as a function of percent silicate.

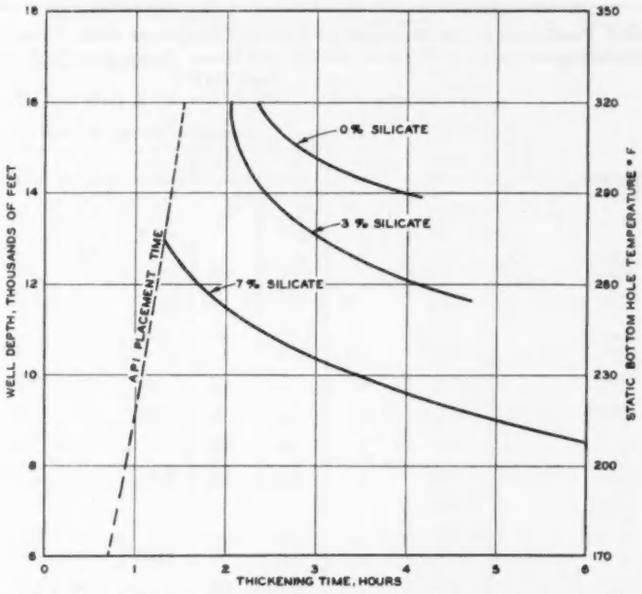

FIGURE 5—Thickening time for the 40 percent DE System as a function of percent silicate.

Function of Silicate. Since CMHEC acts as a retarder of the thickening time, the low density systems containing CMHEC as the only other additive develop little or no strength in 24 hours when cured at atmospheric pressure at temperatures to about 180° F. This demanded incorporation of a material which would accelerate the thickening and setting reaction without adverse effect on the water-loss. Numerous materials were tested to determine their suitability for this purpose. Commonly applied accelerators like calcium chloride nullified water-loss control by CMHEC when used at concentrations high enough to give the desired acceleration.

Sodium silicate was discovered to be very promising. Sodium silicate is obtainable as a solid or as a solution with varying silica to soda ratio. Painstaking work established that the best type of silicate had a silica-to-soda ratio of two to one. For example, the data in Table 6 show that maximum 24-hour strength is developed by slurries cured at 140°, 160° or 180° F. when the silica-to-soda ratio is 2.0. Other tests established that anhydrous silicates when dry blended with the cement are less active accelerators of the thickening time than are hydrated salts. However, concentrations of anhydrous silicates appreciably higher than those of hydrated salts might be applied by dry-blending with cement, DE and other ingredients to achieve greater early strength. Therefore, an anhydrous silicate with a silica-to-soda ratio of 2.0 was selected. Unless otherwise stated the silicate used in all tests represents a powdered, anhydrous product having this optimum silica-to-soda ratio.

Properties of Slurries of the Low Density, Low Water-Loss Cements. The above tests established approximate concentration ranges for each ingredient in order to produce a stable slurry having a low water-loss. To define conditions for use of these cements it was then necessary to determine pumpability of the slurries and the strength the cement would develop under well conditions.

The thickening time of the 20 and 40 percent DE systems under simulated well conditions is shown as a function of well depth for various concentrations of sodium silicate in Figures 4 and 5. With either system, the thickening time is adequate to permit pumping to depths of 16,000 feet when the silicate concentration is zero. Even with 7 percent silicate either the 20 or 40 percent DE system may be pumped to 12,000 feet. Consequently, unless the cementing depth is greater than 12,000 feet or if pumping time at shallower depths is exceptionally long due to volume of cement being mixed or for other reasons, the thickening time of these slurries permits a large margin of safety.

It should be noted that the thickening time as reported in Figures 4 and 5 were determined with 120 and 220 percent water, respectively. These water-contents will be generally preferred, but higher or lower water contents may also be applied. The thickening time is proportional to the percentage water, but no fixed rule may be given regarding the rate of change in the thickening time with change in percentage water. The available data show that variations amounting to ±25 percent water by weight of cement will not be serious unless the margin of safety between the thickening time as given in Figures 4 and 5 and the estimated pumping time for the given well conditions is small, e.g., less than 30 minutes.

The compressive strengths developed by these cements under simulated well conditions are reported in Tables 7 and 8. Some of the results are illustrated in Figures 6, 7 and 8. For either the 20 or 40 percent DE system these results illustrate the marked effect of sodium silicate on the 24-hour strength. Limited data indicate that there is a linear relationship between strength and the loga-

TABLE 6—The 24-Hour Compressive Strength Developed by Slurries Prepared With Class A Cement, 40 Percent DE, 2 Percent Bentonite, 1.5 Percent CMHEC, 220 Percent Water, and 3 Percent of Various Sodium Silicates(*) When Cured At 140°, 160°, and 180° F.

Silica to Soda Ratio	Compressive Strength, psi†, when Cured 24 Hours at:		
	140 F.	160 F.	180 F.
0.67	339	488	778
1.00	415	499	825
1.60	489	757	1046
2.00	539	760	1166
2.50	451	646	666
3.22	468	746	515
3.75	396	662	525

* The silicates were predissolved in the water used to prepare the slurries.
† Compressive strengths are the average of three cubes.

TABLE 7—Compressive Strength of Cements Prepared With Class A Cement, 20 Percent Diatomaceous Earth, 1 Percent CMHEC, 2 Percent Bentonite, 0-12 Percent Sodium Silicate and Water. The Slurries Were Cured at Simulated Well Conditions*

Depth, Feet	Water, Percent	Time, Days	Compressive Strength, psi, with Indicated Percent Silicate							
			0 Percent	0.5 Percent	1 Percent	3 Percent	5 Percent	7 Percent	10 Percent	12 Percent
0	120	3	....	....	....	....	100	120	200	....
0	120	7	....	....	....	....	375	520	680	....
2,000	120	1	....	....	....	210	340	420	450	....
2,000	120	3	225	325	445	710	1,020	1,290	1,360	1,450
2,000	140	1	....	....	....	110	190	255	275	....
4,000	120	1	15	130	170	570	950	1,140	1,150	....
4,000	120	3	1,260	....	1,410	1,430	1,520	1,550	1,520	....
4,000	140	1	20	70	125	420	670	800	1,000	1,000
6,000	120	1	910	1,070	1,070	1,440	1,430	1,490	1,790	....
6,000	140	1	540	660	730	880	930	920	1,260	1,320
10,000	120	1	1,040	1,220	1,360	1,340	1,530	1,520	1,800	1,840
10,000	140	1	....	....	....	930	1,020	....	....	....
14,000	120	1	980	1,050	1,160	1,560	1,640	....	....	....
14,000	120	3	1,100	1,170	1,230	1,450	1,480	....	....	....
14,000	140	1	650	780	910	1,060	1,090	....	....	....
14,000	140	3	730	840	860	1,010	1,130	....	....	....

* Curing pressure was atmospheric for zero depth, 1600 psi for 2000 feet and 3000 psi for other depths. After the initial 4-hour heating period the temperature was 80 + (0.015) (depth).

TABLE 8—Compressive Strength of Cements Prepared With Class A Cement, 40 Percent DE, 2 Percent Bentonite, 1.5 Percent CMHEC, Sodium Silicate, and Water When Cured Under Simulated Well Conditions*

Depth, Feet	Water, Percent	Curing Time, Days	Compressive Strength, psi, when Containing				
			0 Percent Silicate	1 Percent Silicate	3 Percent Silicate	6 Percent Silicate	10 Percent Silicate
2,000	200	1	0	0	6	36	100
2,000	220	1	0	0	2	23	70
2,000	220	3	34	70	170	300	520
2,000	240	3	32	60	125	270	390
4,000	200	1	17	36	135	440	670
4,000	220	1	12	20	95	340	500
4,000	240	1	8	16	95	330	430
4,000	260	1	10	15	65	240	360
6,000	200	1	130	165	870	890	790
6,000	220	1	54	145	730	680	620
8,000	200	1	900	1,030	1,190	1,145	990
8,000	220	1	520	805	1,040	1,020	780
8,000	240	1	210	370	840	770	640
8,000	260	1	21	360	650	630	520
10,000	200	1	1,400	1,450	1,250	1,460	1,230
10,000	220	1	1,010	1,140	1,020	1,220	1,000
12,000	200	1	345	385	660	1,510	1,350
12,000	220	1	315	320	440	1,300	1,050
14,000	200	1	160	380	1,020	1,470	1,320
14,000	220	1	115	270	790	1,330	1,110
14,000	240	1	100	240	500	1,140	820
14,000	260	1	75	150	285	810	680
14,000	220	3	1,380	1,240	1,290	1,400	1,120
14,000	240	3	1,160	1,170	1,060	1,220	930
16,000	220	1	280	325	430	990	710
16,000	240	1	190	270	365	700	620
18,000	220	1	1,040	1,090	980	950	750
18,000	240	1	930	970	860	850	650

* Curing pressure was 1600 psi for 2000 feet and 3000 psi for all others. After the initial 4-hour heating period the temperature was 80 + (0.015) (depth).

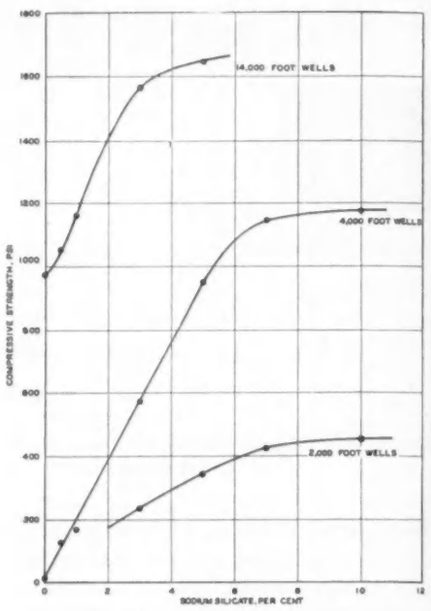

FIGURE 6—The effect of sodium silicate on the 24-hour compressive strength of cements containing Class A cement, 20 percent DE, 1 percent CMHEC, 2 percent bentonite, and 120 percent water when cured at simulated well conditions.

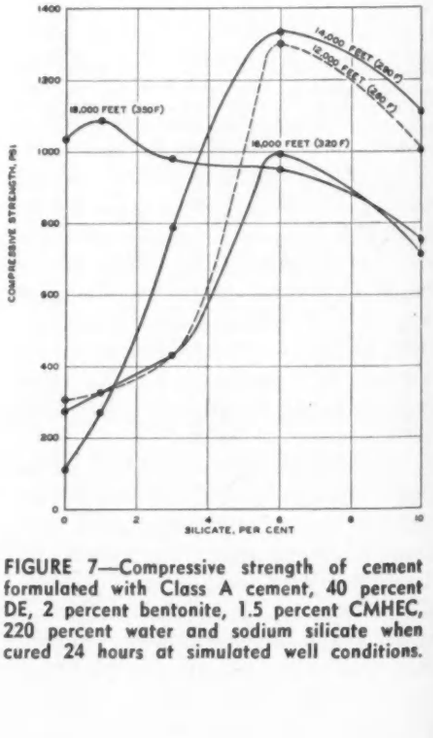

FIGURE 7—Compressive strength of cement formulated with Class A cement, 40 percent DE, 2 percent bentonite, 1.5 percent CMHEC, 220 percent water and sodium silicate when cured 24 hours at simulated well conditions.

rithm of time during the first seven days when the cement is cured at atmospheric pressure. During this period the strength is a direct function of silicate concentration but thereafter is essentially independent of the silicate. Hence, the ultimate strength developed by the slurry is believed to be independent of the silicate.

For the 20 percent DE system, there is little evidence that retrogression of strength occurs at high temperatures. With the 40 percent system, however, retrogression is apparent. This is illustrated in Figure 8[5] which gives curves of equi-strength as a function of depth and silicate concentration. This phenomenon has been previously observed with various oil-well cements. This work[22] showed that at some critical temperature—

about 220° to 240° F.—the 24-hour strength of the cement was at a maximum and that as the temperature increases the 24-hour strength decreases. The period of retrogression generally lasted for about 7 days.

From Table 7 or Figure 9 for the 20 percent DE cement it is apparent that 24-hour strengths greater than 200 psi may be obtained at depths of 1000 feet provided the silicate concentration is more than 7.0 percent. However, even with 10 percent silicate in this system, no strength is developed in 24 hours at 80° F. and atmospheric pressure. Hence, the upper placement limit for this system is dictated by the strength developed; and with a 24-hour waiting-on-cement period the limit is about 1000 feet. Similarly, with the 40 percent system the upper placement limit becomes about 2300 feet when using 10 percent silicate. With either the 20 or 40 percent system, increase in the waiting-on-cement time to 48 hours would decrease values for the upper placement limit by about 50 percent. These conclusions for placement limits are based on results obtained when the water content of the slurry is 120 and 220 percent with the 20 and 40 percent DE systems, respectively. The strength developed by these slurries is a direct function of the slurry density or an inverse function of the water content as illustrated in Tables 7 and 8. However, variations in the water content amounting to ± 20 percent by weight of the cement do not appreciably alter these conclusions.

The previous discussion emphasizes the need for proper choice of cement composition to meet the conditions of the cementing operation. This applies not only for the systems herein described but also for other well cements. To facilitate proper selection of the cement composition for the particular job or to define the operable range of a given composition, Figures 9 and 10 may be applied. These charts summarize the most pertinent data by showing thickening time and strength as a function of well depth and silicate concentration.

For example, using Figure 9, the 20 percent system containing 4 percent silicate will have a 24-hour strength of 200 psi or more at depths greater than 1400 feet and the thickening time will be greater than 1.5

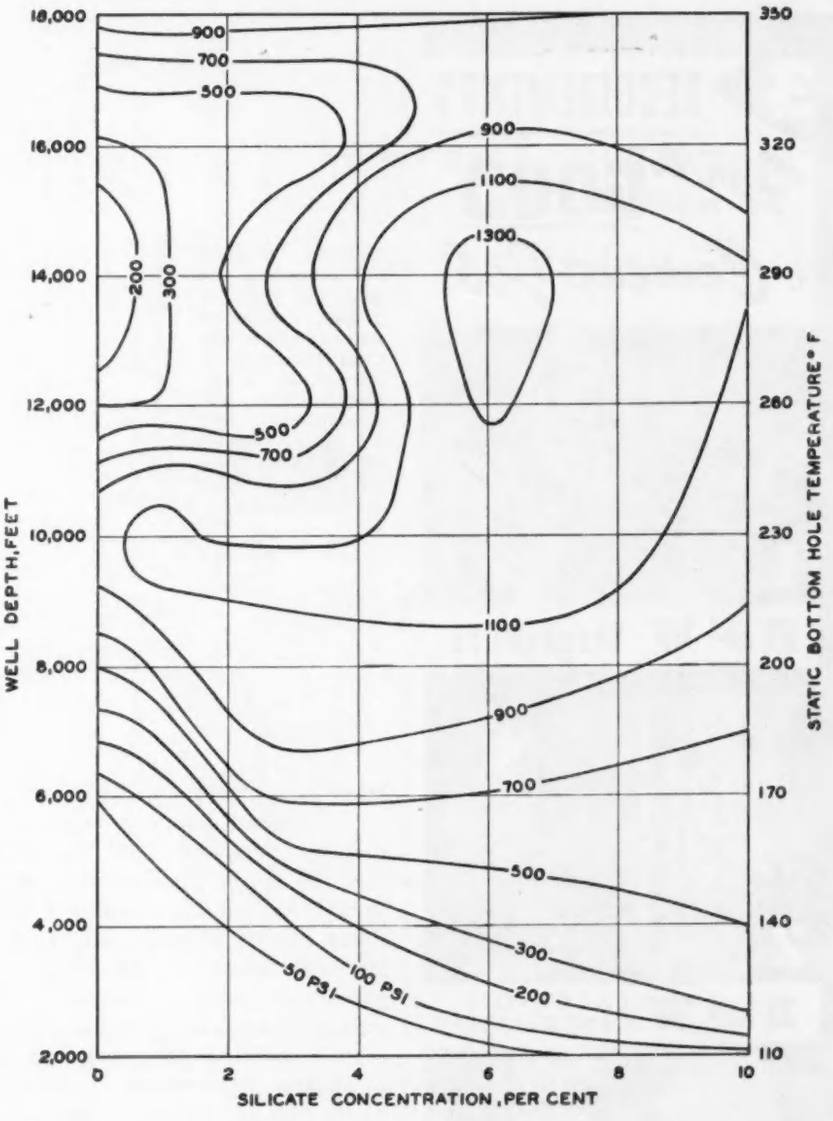

FIGURE 8 (Above)—Compressive strength of cement formulated with Class A cement, 40 percent DE, 2 percent bentonite, 1.5 percent CMHEC, silicate, and 220 percent water as a function of curing temperature.

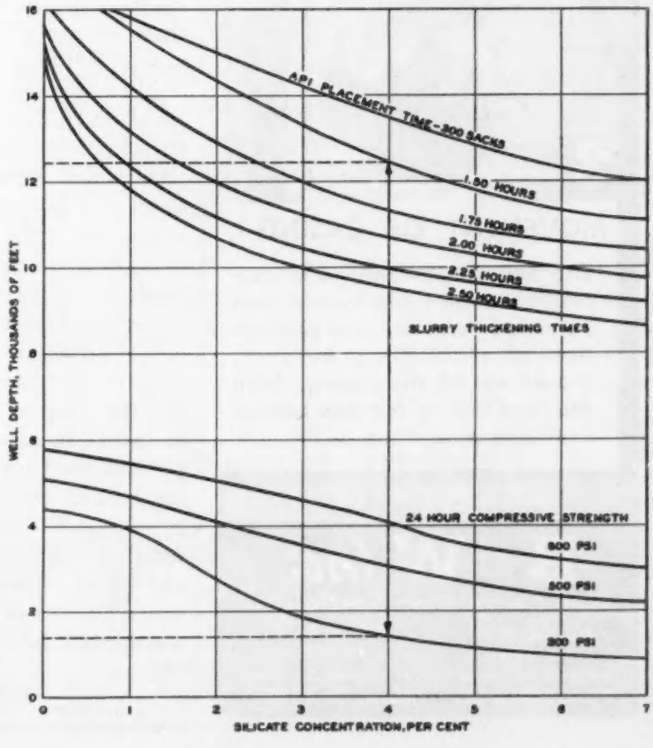

FIGURE 9 (Right)—Chart for estimating the thickening time and 24-hour strength of slurries prepared with Class A cement, 20 percent DE, 2 percent bentonite, 120 percent water and 0-7 percent sodium silicate, dotted line gives example cited in text.

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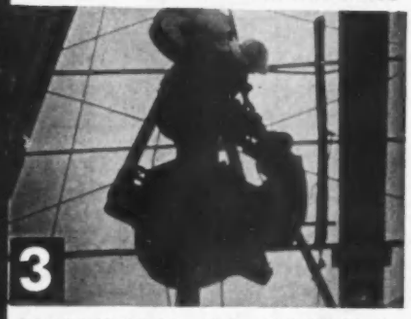

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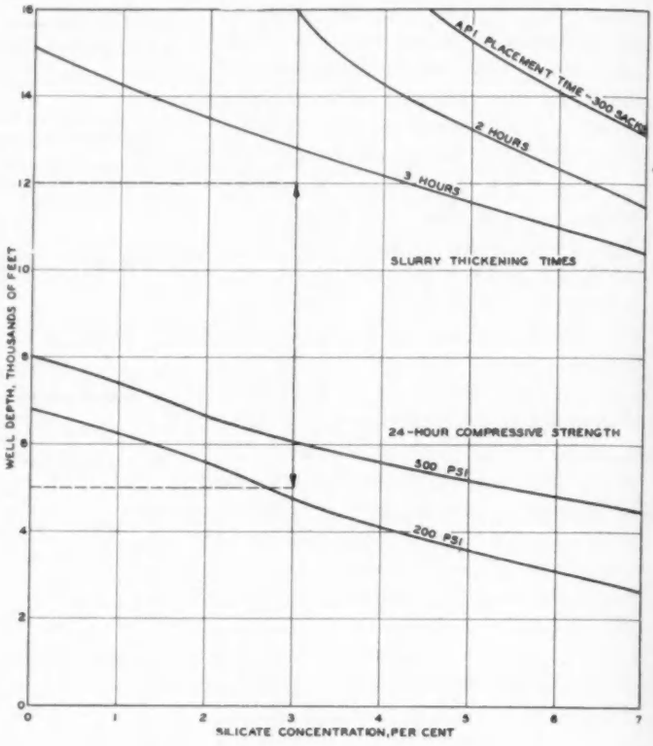

FIGURE 10—Chart for estimating the thickening time and 24-hour strength of slurries prepared with Class A cement, 40 percent DE, 2 percent bentonite, 220 percent water, and 0-7 percent sodium silicate. Dotted line gives example cited in text.

hours at all depths to 12,400 feet. The operable depth for this composition is, therefore, between 1400 and 12,400 feet. As another example, if it is desired to use an 11 pound-per-gallon slurry to cement casing set at 12,000 feet with fill-up to 5000 feet, the 40 percent DE system containing 3 percent sodium silicate would allow more than 3 hours for placement and give a 24-hour compressive strength between 200 to 500 psi at depths between 5000 and 6100 feet and greater than 500 psi at depths between 6100 and 12,000 feet.

Many factors pertinent to field application of these low water-loss systems have been considered. In field tests which have been conducted to date, no factors have been found which seriously impair the applicability of these systems. The dry blends used for preparing the slurries have been found to remain stable in storage. Contaminants such as soluble electrolytes which might be present in the make-up water can be tolerated in amounts to at least 10,000 parts per million. Contamination with drilling mud or the reagents used in muds is, of course, undesirable but the effect of such contamination is not considered more serious than with other types of cement. Field tests with the systems herein described are continuing.

REFERENCE

A complete list of references appeared with Part 1 of this article, August 1, 1955, World Oil.

ACKNOWLEDGMENT

The application of diatomaceous earth of a suitable type for control of the slurry density was suggested by Roy Bobo of Phillips Petroleum Company's Production Department.

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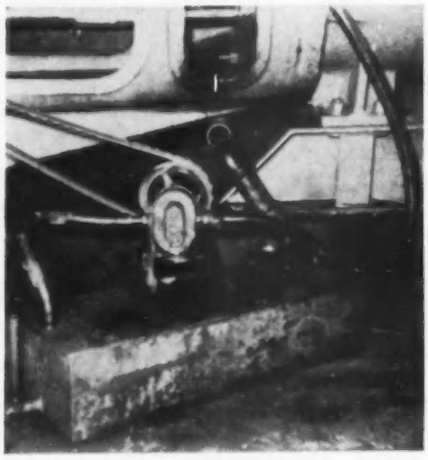
Re-Cycle Pump Rod Lubricating Oil



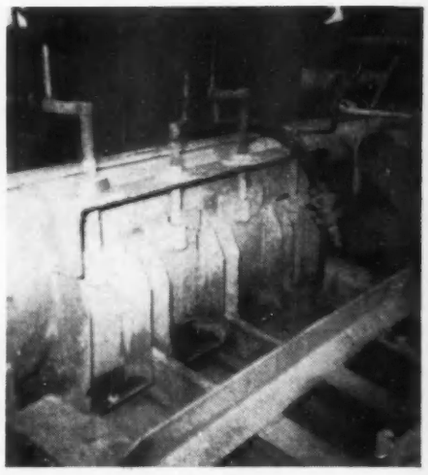
Lubricating oil used to lubricate the pump rods can be re-cycled by a compact and portable oil pump. Short connections from the bottom of the stuffing gland wells drain the lubricating oil into a small metal container. A small pick-up pump attached to the box is operated by belt drive from the pump shaft. This pump picks the oil up out of the sump and pumps it through a rubber hose connection to the top of the pump where it again is used to lubricate and cool the rods. The unit is small and can be transported separately of the mud pump or easily transferred to another pump.

Collapsible Stand Elevates Fuel Tank

To make compact loads, one contractor designed legs for the fuel tank stand that fold back when the tank is loaded for moving.

The tank is mounted on a frame made of 3-inch pipe with 1-inch stringers along the side to stiffen it. A loop is welded to the front of the frame for the hook on the winch line. A 2-inch frame is made and welded up so that the top pieces go through the front and back pieces of the 3-inch as shown. Plates are welded to the sides of the legs and 3-inch frame so that a piece of 2-inch, slotted, will fit over the plates. Matched holes are burned through the ends of the 2-inch braces and the plates. Pins with chains attached are placed in the holes to hold the legs erect.

When time to move, the truck is backed up to the support, the pins removed and the load skidded over onto the truck with the winch line. The legs lay flat alongside the skids.



Divert Mud from Shaker By Screw-Lift Gate System

When necessary to service a shale shaker, such as replacing, repairing or simply washing down the screen, some way must be provided to divert the mud flow away from the shaker. Of the various ways that the mud can be blocked off from the screen, one flexible system is to build a unit of four screw-lift gates in the side of the flow line. These gates provide entrance of the mud to the shale shaker. Any one of the gates can be opened or closed independently. The screw-lift mandrel passes through a threaded section in the upper part of the frame and into another threaded section attached to the gate. The gate moves up or down in its grooved frame as the crank is turned.

Make Mud Tank Walkway From Angle Iron, Grating

Since steel mud tanks are placed on the ground to give a flooded suction to the mud pumps, a walkway is needed to provide access to the working rim of the tanks. Large pieces of boards are sometimes used, but as noted in the photo, a safer and more attractive walkway can be constructed of angle iron and steel grating. The walk is built in rectangular sections that are hinged to the top

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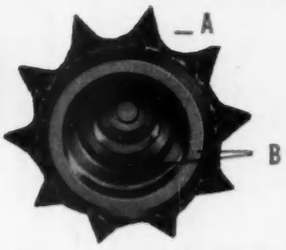
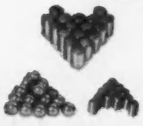


A Correct heel design and hard facing B Bearing races precision ground.

BALLS & ROLLERS



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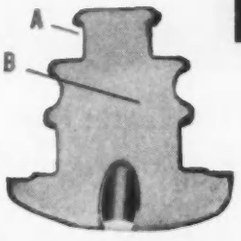
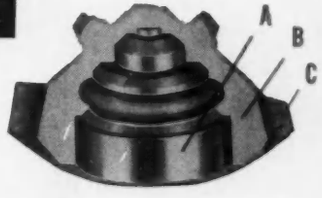
SECTIONS



Horizontal section of Leg Journal shows
A hard case for long wear
B tough, ductile core which gives strength and shock resistance.



Cone section shows careful balance between
A bearing size
B shell thickness
C tooth depth

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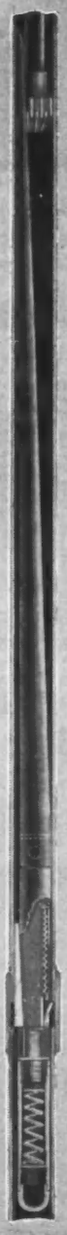

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of the mud tanks. In transport these walkways are folded against the sides of the tanks. On location the walkways swing up into position and are supported by braces that also can be folded into position for transport.

Mount Heater Fuel Tank On Side of Doghouse

The side of the doghouse is a convenient place to mount the tank for kerosine to supply a heater. Cap a piece of 6-inch pipe on both ends and weld a 2-inch collar thread in the top and a ½-inch outlet to the bottom. Tack weld the tank to the side of the doghouse just above the heater.

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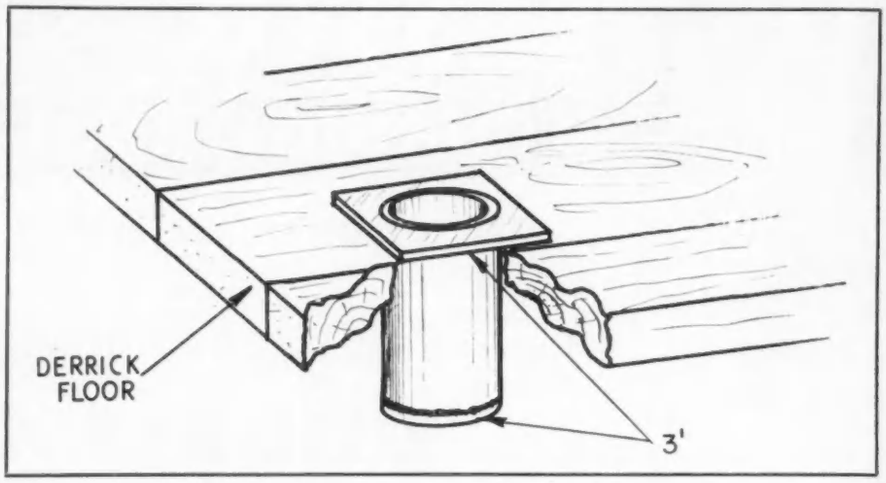


Extend Tool Rack from Derrick Floor

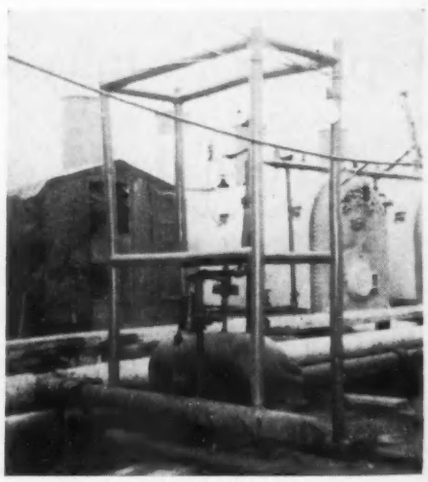
During drilling operations, small tools and subs placed on or taken off the drill stem often are left on the derrick floor. A simple holder or rack can be made for these tools by taking short pieces of surface pipe and welding a frame on one end. The other end of the pipe is sealed. The unit is suspended by the frame and extends below the derrick floor. These holders can be made in single or multiple units.

Shop-Made Hearing Aid Locates Pump Trouble

Pump trouble occurring on power rigs is sometimes hard to locate because of other noises. Valve trouble and foreign material lodged in the fluid end can be located by sound and, to save the crew the time and trouble of removing all eight valve pot lids, one engineman devised a hearing horn to aid him in locating the source of trouble. A tin can was cut and folded in conical shape and a piece of .008-inch shim metal was used to cover the large end. A 3/16-inch brass rod was fastened to the small end. By placing this device alongside the valve housings, the sound of the action of the valves is magnified and a valve that is not working properly easily is detected.

Build Skid Mount from Pipe To Protect Lubricator

On steam rigs a lubricator is located somewhere along the steam lines so that a lubricant may be injected into the steam stream. If the lubricator is not well protected, the small lines may be accidentally broken. To avoid this situation a Gulf Coast contractor built a skid mount for his lubricator that completely protects it. The mount can easily be constructed from 3-inch pipe. The mount plugs into the steam line by means of a hammer joint.



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Light Bracket, Extension Keep Location Well Lit

To keep work areas around a drilling location well lit, a Texas oil company has constructed a T-bracket from angle iron on which flood lights are mounted. An extension from the bracket is made from a straight piece of angle iron which is bolted to one arm of the T-bracket. This allows flexibility and maneuverability when necessary to direct more light on certain operations.

Make Boiler Chemical Mixer From Steel Drum, Agitator

A handy mixer and lubricator for boiler water chemicals has been devised by one Texas contractor to facilitate injection of scale and corrosion inhibiting chemicals. The device consists of a steel drum with a paddle type agitator that is operated by a crank handle on top. The compound is mixed in the tank and slowly fed into the boiler by tapping into the feed water supply line.

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Uses of neutrons and gamma ray curves: The gamma ray curve is a measurement of the amount of radioactivity that is natural in the formation penetrated by the bore-hole. The neutron curve is the measurement of the amount of fluid in the formation. It is obtained by bombarding the formation with a strong source of neutrons and measuring the induced radiation. These two curves, with a casing collar log, provide the complete radioactivity well log which indicates formation characteristics in either open or cased holes.

• • •

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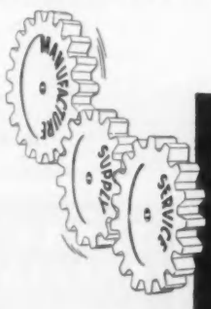

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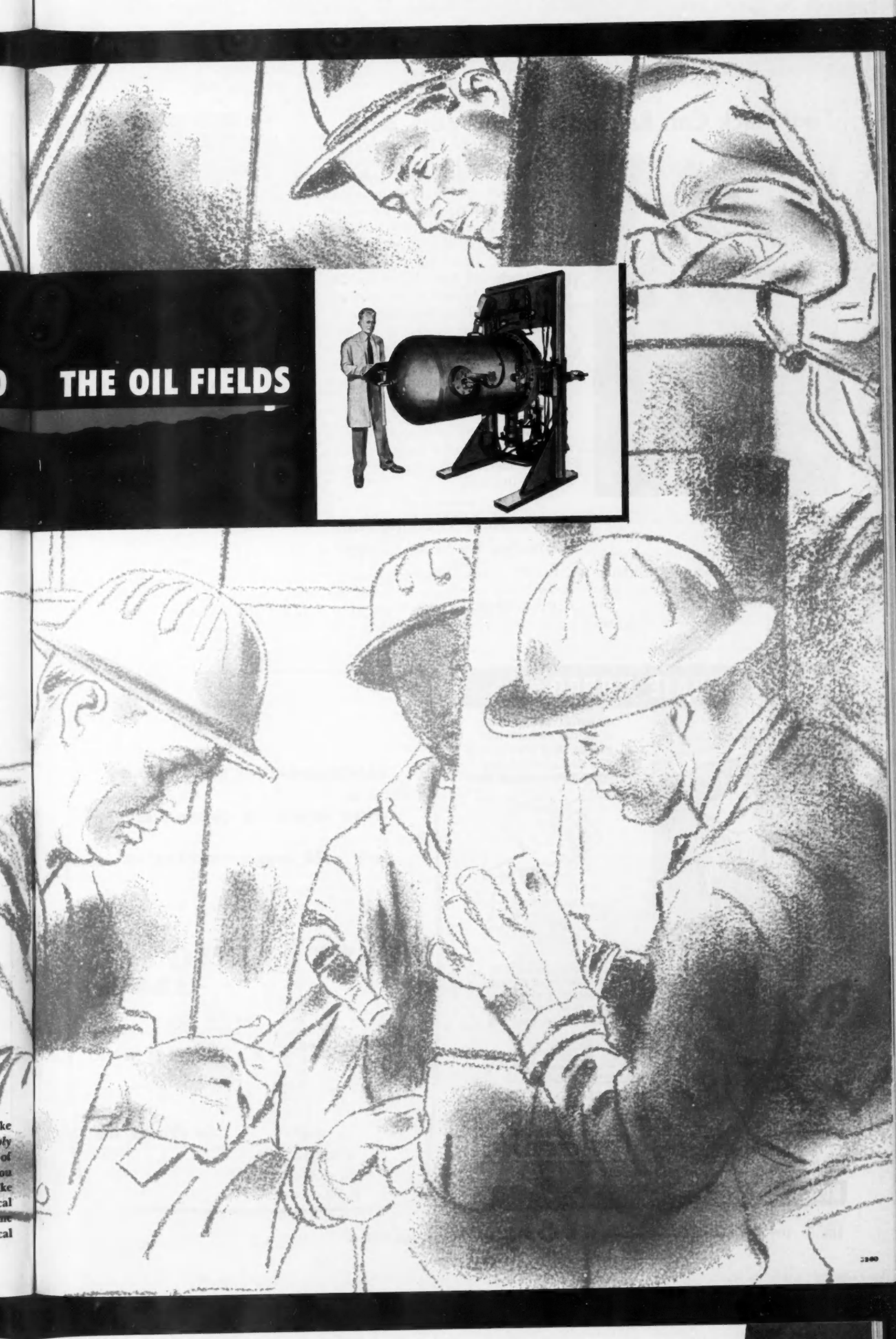
THE OIL FIELDS

Tool Rack Can Be Spotted in Work Area

This lightweight skid-mounted tool rack can be moved about the derrick floor when major equipment overhaul is in progress, providing the mechanic with needed tools arranged in a convenient manner.

The illustrated rack is approximately three feet high and four feet wide, weld constructed of angled 2-inch pipe and covered with light gage sheet steel. Rod type hooks are welded against the face of the rack to permit hanging tools in desired positions.

Inside the angled structure, and approximately 1½ feet above the base, is a section of ¼-inch sheet metal suspending a small pull-out drawer designed for storage of small hand tools and easily lost parts. The slide base of the drawer is further supported by two lengths of one-inch angle iron connecting both the drawer and rack base.

Additional storage space is made available by welding another section of sheet metal across the entire base area of the rack.

Heater Near Working Area Protected by Steel Guard

In cold weather, if a heater is close to a working area, such as on the derrick floor or in the mud house, safety precautions should be taken. One contractor uses a simple protector constructed of steel mesh and metal strips that has been shaped to fit around the heater. The protector is held in place about two inches from the heater by metal spokes.

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November 26, 1954

Fred E. Cooper, Inc.
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Attention: Mr. J. W. Allen, President

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I do not know of any better recommendation than to say, just talk to any production man for whom we have done a job or any crew member. Our unit operator, Clayton Robinson, says mj did not know such a good machine was built, and just send any man to me for a recommendation".

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PEERLESS WELL SERVICE

By: R. L. Schlemeyer
R. L. Schlemeyer, Owner

RLS/m

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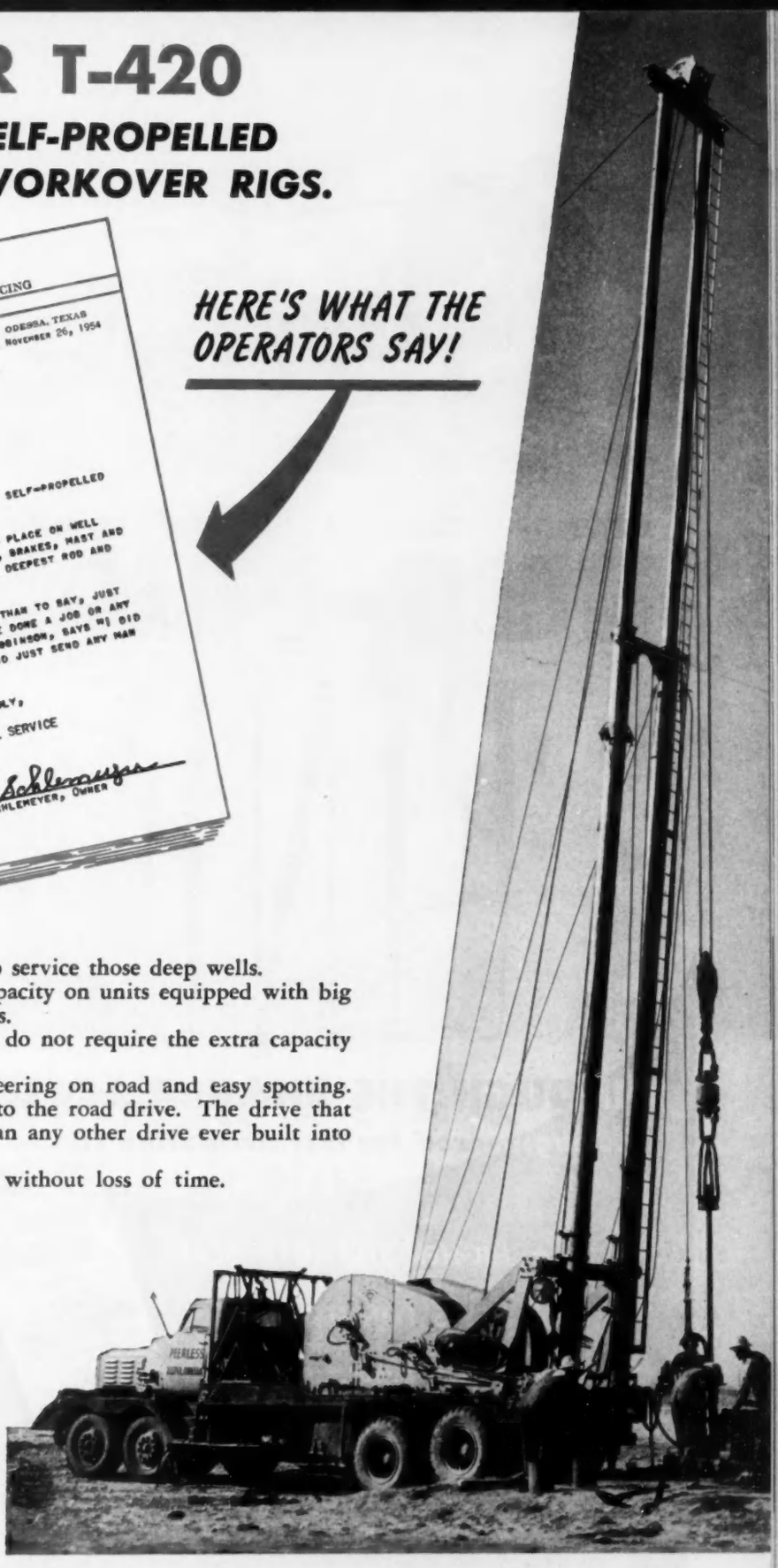

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Torqmatic drive to the winch drums and to the road drive. The drive that is safer and easier to operate and faster than any other drive ever built into a servicing rig.
Shifts gears instantly at full open throttle without loss of time.
Eliminates shocks to sub-surface equipment, winch and road drives.
There is no bucking or stalling engine in sand and mud or when spotting on location.
There is no engine clutch to operate or maintain.
Air friction clutches in the drums are self-adjusting.
Why not let a Cooper sales engineer explain in detail the many features and advantages of Cooper Torqmatic drive rigs.

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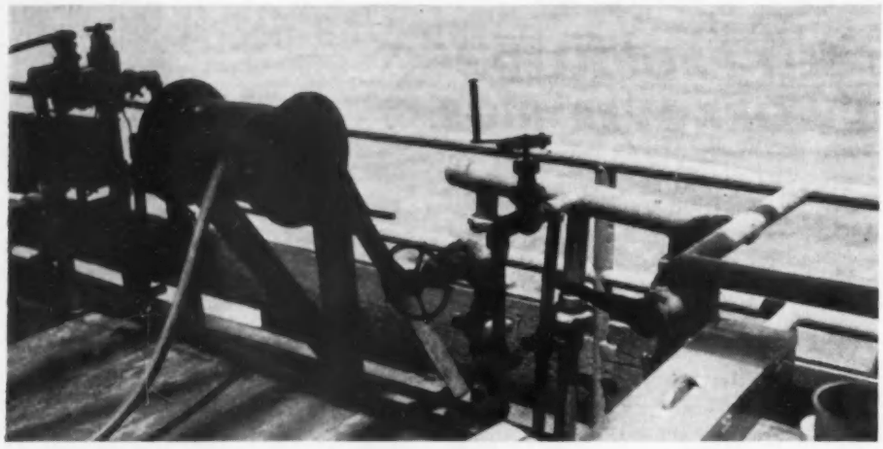

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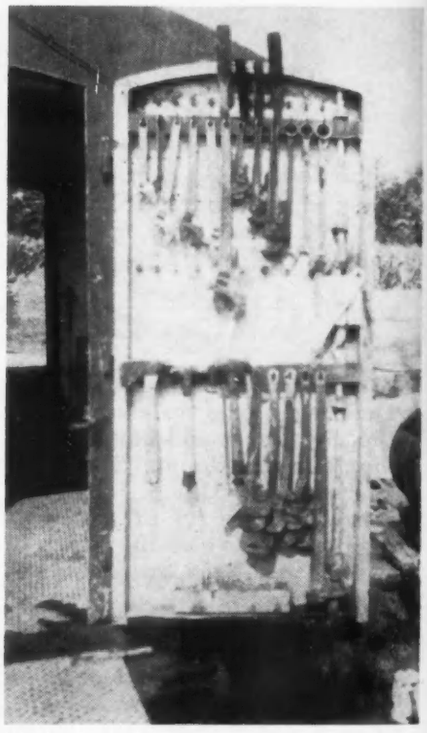
Water Hose Storage Reel Made from Scrap Material

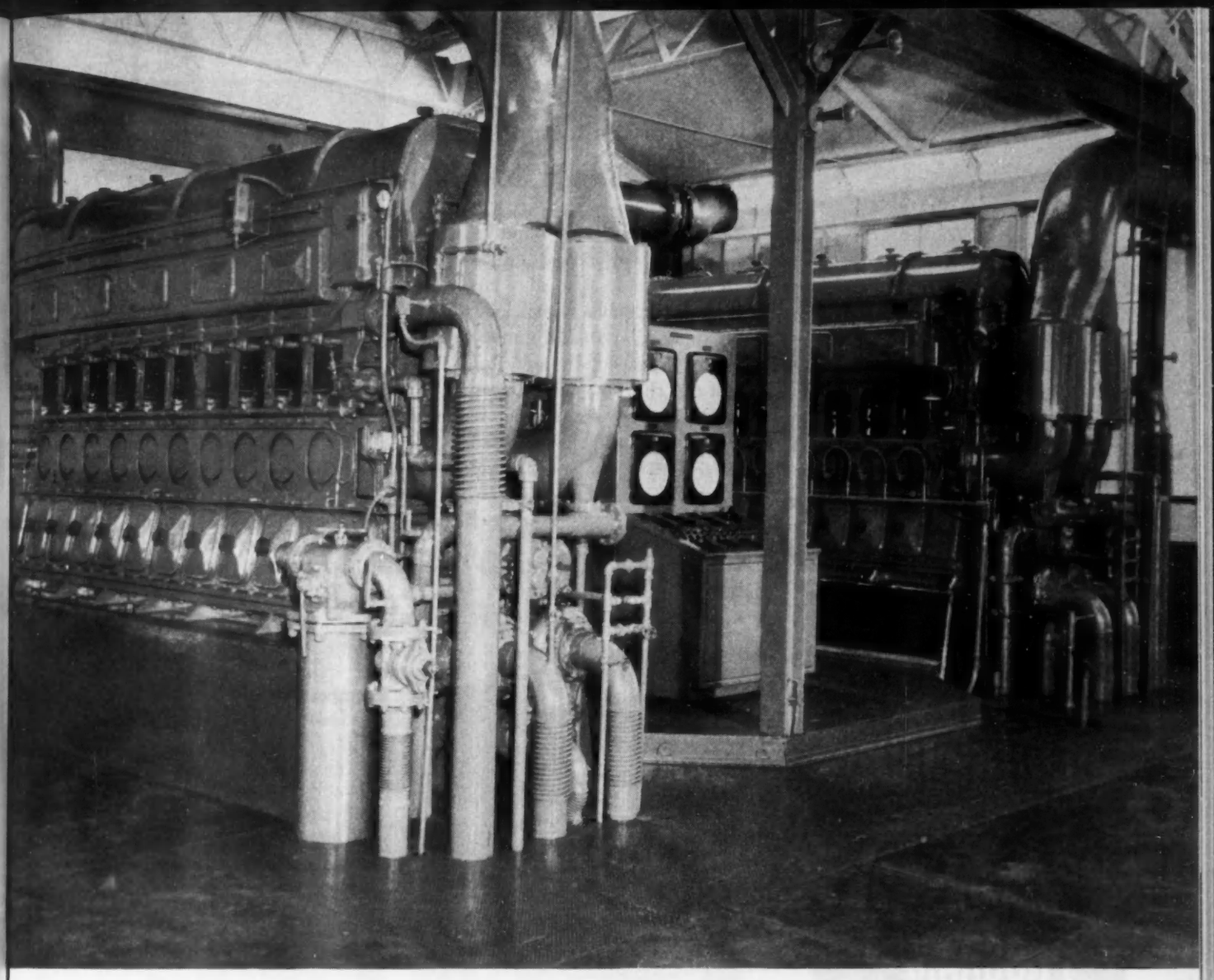
Water hoses used to wash down the rig and equipment often present a safety hazard if not properly stored. One of the most efficient methods of storing such a hose, and one that makes it readily accessible, is the use of a reel.

A handy reel can be made of scrap metal and mounted on angle iron braces in an out of the way place on the floor. A crank attached to the reel drum makes it easy to reel in the hose when not in service.



Inside Doghouse Door Converted to Handtool Rack

On small rigs where space is at a premium it is often difficult to find suitable storage and working areas. The inside of the doghouse door on one rig has been converted to a hand-tool rack. Two pieces of angle iron have been welded across the door and a number of hooks, properly spotted, have been welded to the angle iron. Here, small hand tools are handy and can be locked up readily if the rig is temporarily stacked.



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—In spite of operating at an average load of only 800 horsepower, these 1600 h.p. O-P's established an average fuel consumption of .37 lb. of fuel per horsepower-hour.

—In this period, the three new O-P stations were pumping more than 97% of the time, on a three-tour-per-day basis. Their performance has brought the entire operation up to maximum capacity.

Conservative rating, low b.m.e.p. and low piston speed make the O-P a dependable, low maintenance engine, ideal for continuous pumping service. Such cost-saving advantages are naturally inherent in a design of an engine that eliminates 40% of the moving (and wearing) parts found in engines of comparable rating.

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Use Safe Chain Handrails On Steps to Rig Floor

The steps and step handrail going to the rig floor need to be sturdy as well as portable. Use of a chain has solved this problem and lends itself to easy installation and removal. This feature is especially adaptable for small rigs that move frequently as the chains can be installed and removed quickly when the rig is to be moved.

Store Tools Conveniently In Box on Mud Pump Frame

A convenient place for storing tools used on the mud pump is on the mud pump itself. One contractor utilizes the space between two of the skid members on the back of the pump.

Made from quarter-inch plate material, the box is deep enough to accommodate all necessary tools. A removable tray is fitted into the top to hold smaller tools. Hooks welded to the sides of the box are for hanging dirty tools until they can be cleaned and put in their proper place.

Steam Line Insulation Serves Dual Purpose

By insulating steam lines and boilers, fuel costs can be cut by a considerable amount. In addition to cutting fuel costs, the insulation provides an attractive covering for the boilers. The insulation, when painted, lends a neater appearance to the rig and does not require the repainting required on the boilers themselves.

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Gel Cements Give Better Perforated Completions

Because . . .

- Perforations have greater depth of penetration.
- There is less likelihood that excessive shattering of the cement will occur.

By **F. D. McEACHERN,** University of Alberta, Edmonton, Alberta, Canada

GEL CEMENTS are being used in increasing quantities with good results. They offer several advantages when completing wells by perforating casing strings set through productive horizons.

Greater penetration of bullets and jet shots is obtained, and less fracturing and shattering of the cement occurs. In addition, gel cements are less expensive, have better "fill-up" qualities and the mix can be adequately controlled.

Gel cements are composed of bentonite mixed with cement and water. Bentonite can be mixed in any proportions up to 16 percent by weight. Above that point, the resulting material is unsatisfactory.

Penetration. One sample of gel cement which had set for five days at room temperature was perforated with a 22 caliber short rifle bullet. The depth of penetration was about 2½ inches, whereas in a sample of neat cement which had set only three days, the penetration was only about 1½ inches. Comparable results would undoubtedly be obtained down the well using the regular perforating bullet and jet shots. Additional tests verify that greater penetration is possible with gel cements.

Figure 1 illustrates effects of gel cement on gun perforating penetration. Penetration test containers constructed of 5-inch diameter tubing in 14-inch lengths were closed off at one end with ½-inch steel plates. These were filled with different percentages of gel cement ranging from zero to 16 percent gel and allowed to cure at 150° F for four days. Test blocks two inches square were poured at the same time to obtain the strength of each sample.

Samples were shot in a test chamber at a pressure of 2500 psi and a temperature of 215° F. Figure 1 shows depth of penetration with bullets increases as gel content of the cement increases.

Fracturing and Shattering. In addition to penetration trouble, there have been indications that fracturing and shattering of the set cement by perforating might be a contributing factor in failure of some jobs to exclude water or gas from oil producing zones. Set cement can be perforated without shattering at about 150 psi tensile strength, whereas at 300 psi or more tensile strength, severe cracking and shattering occurred.[2]

Figures 2 and 3 illustrate how samples of neat and high gel cement react to perforating with 22 caliber bullets. The high (12 percent) gel sample exhibits very little cracking after aging for five days, while the neat cement sample shatters more easily when set for only 24 hours. This work was carried out using samples collected in ordinary tin cans and perforated with 22 caliber, short rifle bullets.

Of five edge wells in the Camrose field, two had the production casing cemented with neat cement; three with gel cement. Perforating the casing caused water to be produced with oil in the first two wells. The remaining three produce no water.

Cost and other factors. Savings from the use of gel cement instead of neat cement are indicated by Figure 4.

Two properties which appear to be quite important are viscosity and settling of the solid particles from the

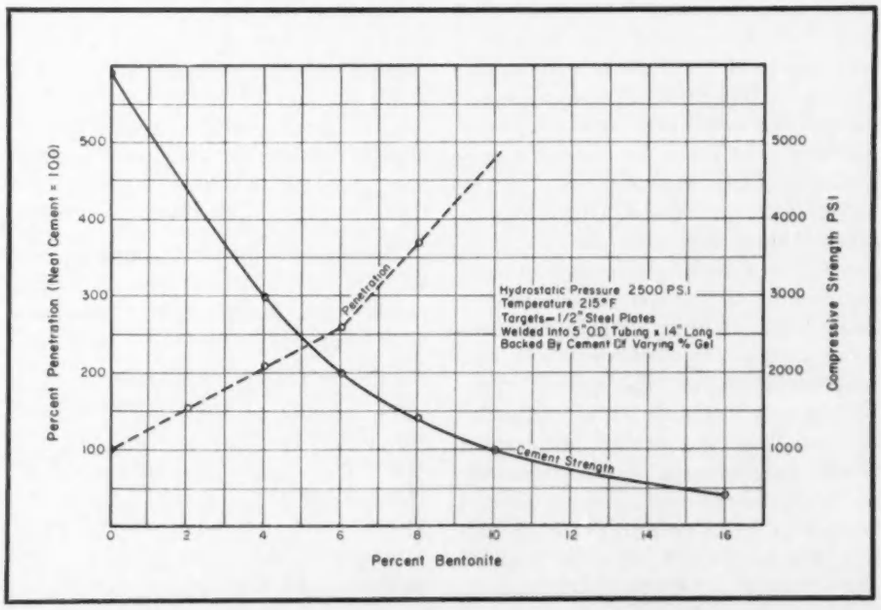


FIGURE 1—Effects of gel cement on gun perforating penetration.

How samples of neat and high gel cement react to perforating with .22 caliber bullets . . .

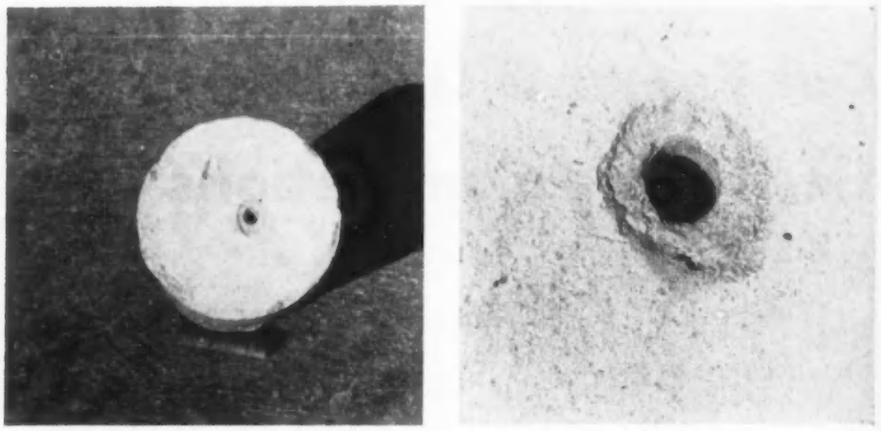
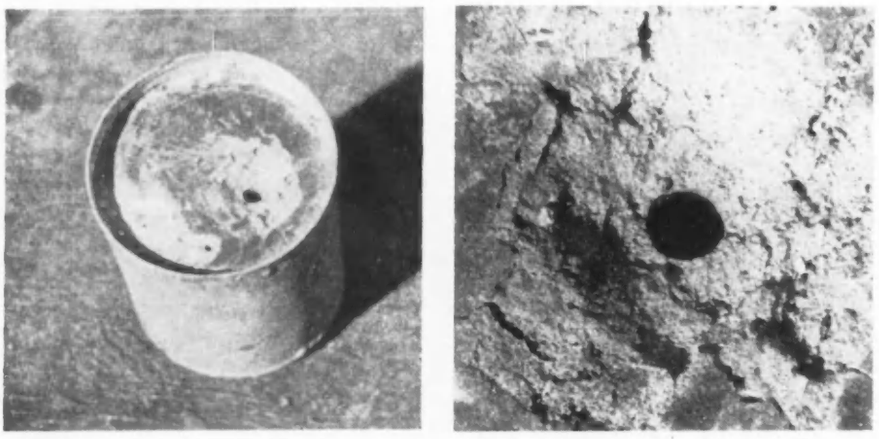


FIGURE 2



- **The high (12 percent) gel samples (above) shows very little cracking after aging five days . . .**
- **But the neat cement sample (left) shatters more easily when set for only 24 hours.**

FIGURE 3

slurry.[4] These two factors can be controlled by: (a) not using less than that amount of water which will give an easily pumpable slurry, and (b) not exceeding that amount of water which will sustain all particles in suspension. Figure 5 shows how much water is required for maximum and minimum water-cement ratios for different percentages of bentonite.

Slurry weight of the cement should be variable to the extent that it can be controlled closely, depending on requirements of the well in which it is being used. In most cases, easier and more satisfactory cementing jobs can be accomplished if the cement slurry weight is only slightly heavier than the drilling fluid. Range of gel cement slurry weights used most extensively in the Camrose and Armena fields is from 12.4 - 12.9 pounds per U. S. gallon. Slurry weights of neat cement vary from 15 - 17 pounds per gallon.

If less than the minimum water is used, it is possible for the slurry to be so viscous that the resistance to flow during placement is sufficient to break down weak formations with a resulting loss of slurry. Also, since the water-cement ratio is already low, only a small amount of water need be lost, due to loose joints, exposed permeability, etc., before the slurry becomes too viscous to move, causing premature stoppage of slurry placement.

Setting and thickening times of extremely low water-cement ratio slurries are considerably shorter than those with the proper amount of water.

If more than the maximum water is used, settling of solid particles from the slurry may occur, causing free water pockets to form within the cement column. Perforating into such a section would expose all the formation adjacent to the water pocket, which might include formations carrying unwanted water or gas.

Pumping time. There must be sufficient time available to place the cement slurry correctly. Experience with gel cements has shown that the time required to pump the slurry is not unnecessarily long. The average time in the Camrose and Armena fields where production is from the Viking sands at 3150 feet is from 15-20 minutes. About the same length of time is required to pump neat cement slurries to this depth.[5]

Fill-up. One of the most troublesome well problems encountered when cementing is difficulty in placing material to the desired height behind the casing because of loss of slurry into "thief" formations and effects of channeling. The first condition may be caused by the formation being of such a porous or fractured nature that the slurry will be lost rather than rise in the annulus. There is a discrepancy of from 10-15 percent between observed and theoretical "fill-up" using gel ce-

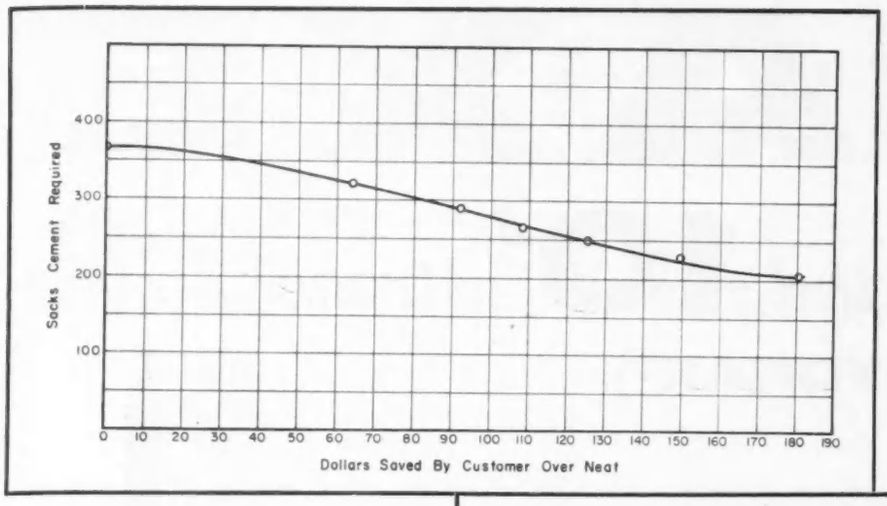


FIGURE 4—Bulk cement cost for various cements plus admixtures.

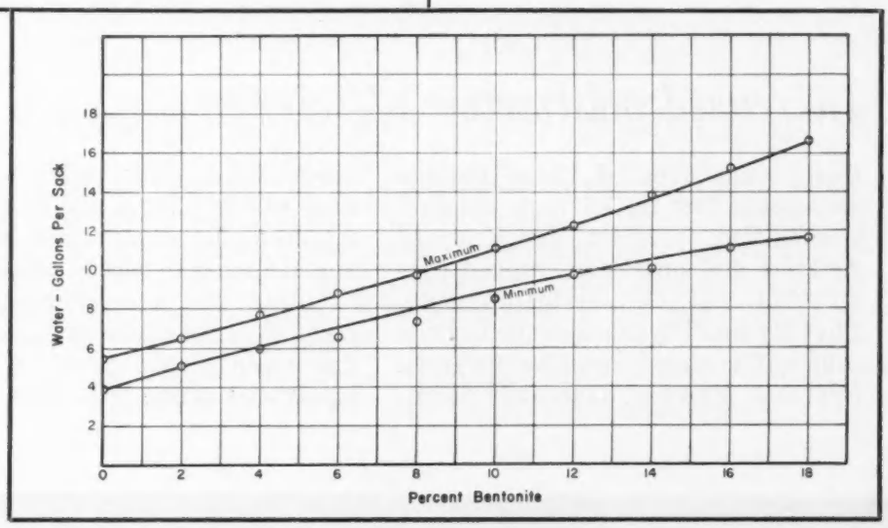


FIGURE 5—Maximum and minimum water-cement ratios for mixtures of cement and various percentages of bentonite.

ments. Discrepancies of 200 percent and more are common with neat cement. These larger differences illustrate the effects of channeling which occur more often with neat cement than with gel cement.

Another and more probable cause of lost circulation is a weak formation breaking down because of the high hydrostatic pressure of the cement slurry. To eliminate this, lighter cement slurry weights are required.

Thickening times. The thickening times for gel-cement slurries are affected slightly by addition of bentonite and water. In no case has it been found in the laboratory (when using the proper amount of water) that the addition of bentonite to A.S.T.M. Type 1 (regular) cement has resulted in a slurry which is not safe to use at well depths in which this type of cement normally is considered satisfactory.

Preparation. At the present time, gel cements can be prepared satisfactorily only by premixing. The method used by one service company is very simple and the procedure is as follows:

The cement, either in bulk or sack form, is dumped onto a conveyor belt carrying the dry cement into a hopper, which controls the feeding rate into a central bin. The cement is carried to this bin by means of an auger; a second auger carries gel to this bin from another hopper. The mix is then carried into a chute with the aid of a third auger, and from there, is dumped into a truck. All three augers turn at the same speed.

Mixing cement and gel in the field has so far proven unsatisfactory as it is very difficult to obtain a uniform blend.

Conclusions. From investigations so far conducted on gel cements, the following conclusions can be drawn:[6]

Perforations have greater depth of penetration when using gel cement instead of neat cement.

Gel cement is weaker and more resilient than neat cement, making it less susceptible to shattering when perforated.

Gel cement is less expensive than the equivalent amount of neat cement.

The lighter slurry weights of gel cements minimize formation breakdowns.

No difficulties arise when pumping gel cement down the hole—its apparent viscosity does not appreciably increase the pumping time ordinarily required.

ACKNOWLEDGMENTS

This is an award winning technical paper presented in a contest sponsored by Lane-Wells Co. and is released to World Oil through courtesy of Lane-Wells Co.

The author wishes to extend particular thanks to J. K. Clark, P. Melnychyn, and A. R. Potter of Halliburton Oil Well Cementing Company, H. Comfort of Imperial Oil Ltd., N. Storey of Murray, Mitchell and Gray, and G. Youell of Dominion Minerals Ltd., for helpful discussions of the subject. Thanks are also directed to B. E. Morgan and G. K. Dumbauld, C. D. Saunders and F. W. Nussbaumer, D. K. Smith, W. P. Sterne, and C. Willson for use of material previously published in their papers.

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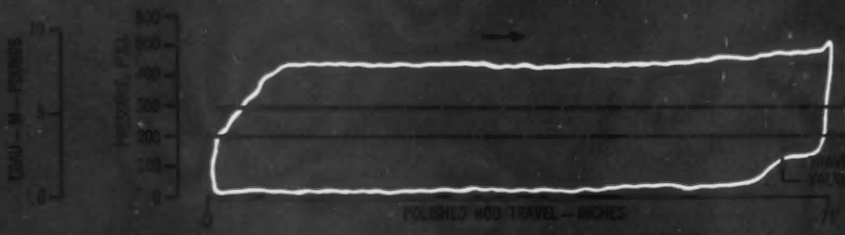

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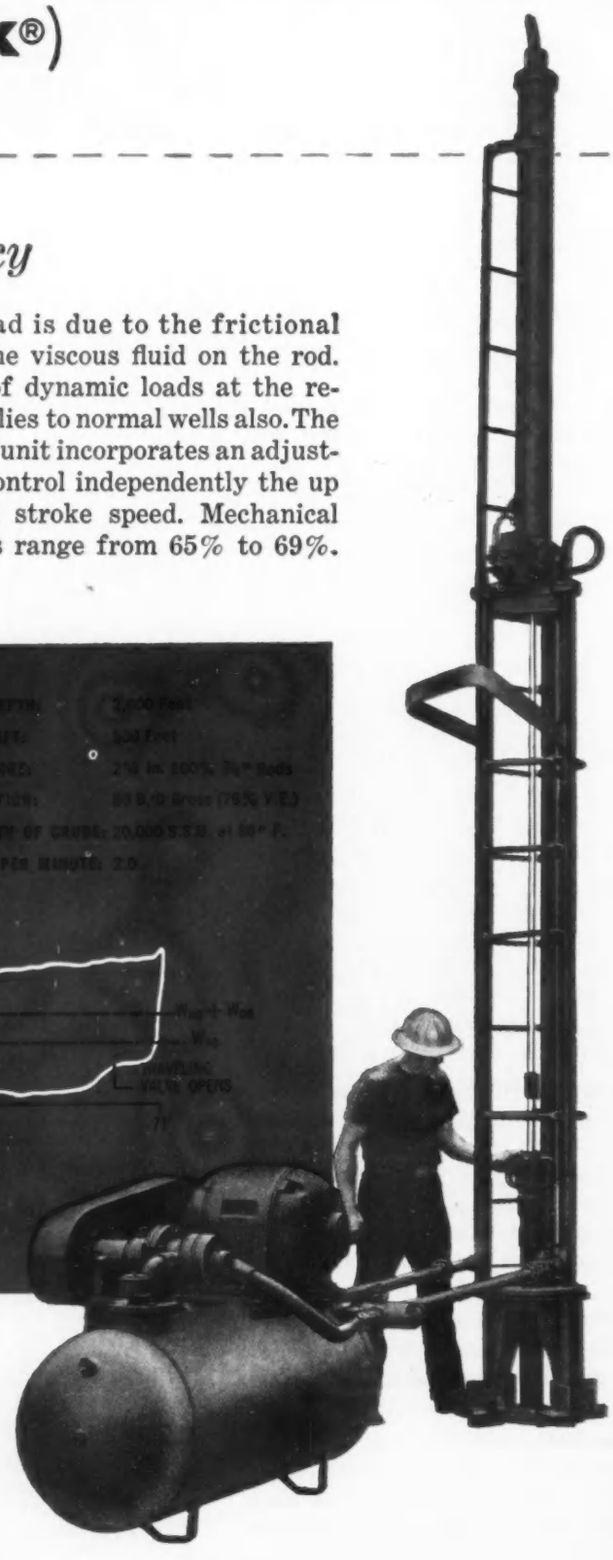

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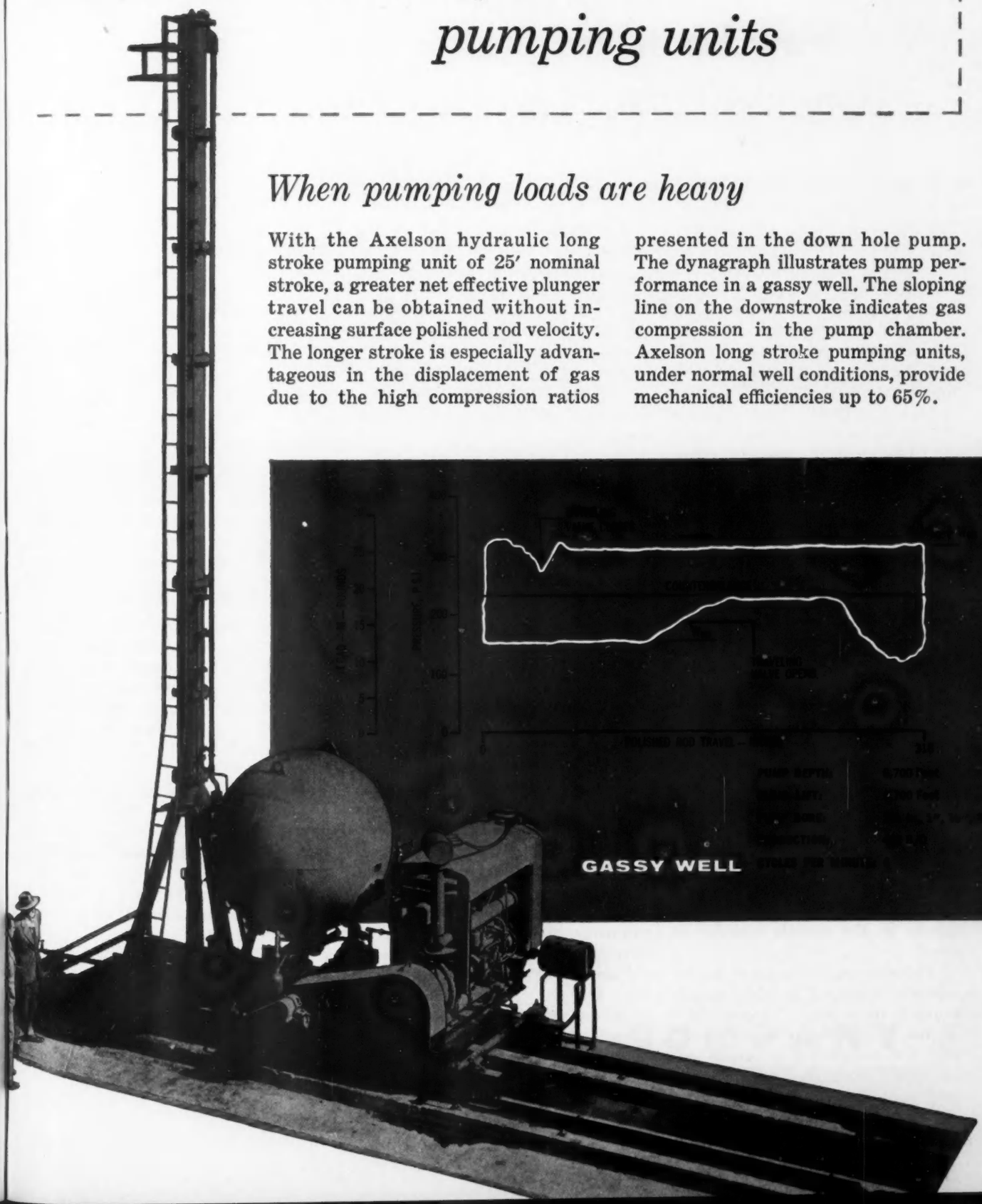


Automatic samplers and meters, long a source of disagreement can bring about a . . .

'New Look' for Field Tank Gaging

By RUDOLPH A. HAMILL, Chief Gager,
Service Pipe Line Company, Tulsa

DISAPPOINTING RESULTS with various automatic metering and sampling devices have resulted in arguments between buyer and seller and have enabled tank gaging to steadfastly resist automation. A new method that will give full consideration to the accurate sampling and recording of temperature, gravity, BS&W, and accurate metering of the volume must be devised. This method must meet with the approval of both the buyer and the seller, it must be accurate within very close limits, and it must be tamper-proof.

Gaging procedure has undergone few basic changes since the early days of the industry. The use of tank tables mathematically computed to express the capacity of a tank, joint gages taken by representatives of the buyer and the seller, and the gravity pricing basis were developed as standard procedures early in the oil industry.

Other phases of the industry have advanced more rapidly toward automation and a large section of management is now asking, either directly or indirectly, why gaging has steadfastly resisted basic revision. The answer probably lies mostly in two fundamental reasons:

1. The custody transfer of oil is tantamount to the custody transfer of money.

2. Experiments with some of the instruments developed to make gaging automatic have been disappointing.

It has been difficult to accurately meter the movements of crude oil, and many companies have experienced poor results with the familiar float-actuated automatic gage. Nevertheless, an increasing segment of management realizes that there is a growing need for improvement in basic gaging practices. As a result, several companies have study and development projects now under way. There is a cooperative spirit and free interchange of ideas among the several companies.

The industry's first efforts to reduce gaging to an automatic basis have been largely directed toward transfers at terminals. This seems basically wrong. If there is any place where the necessary manpower can be afforded to supervise the transfer of oil, it is at terminals where the volumes are usually large and the incremental costs for supervision small, as compared to similar transactions at the lease tank level. Therefore, the possibilities of effecting economic savings is much more important at the lease tank.

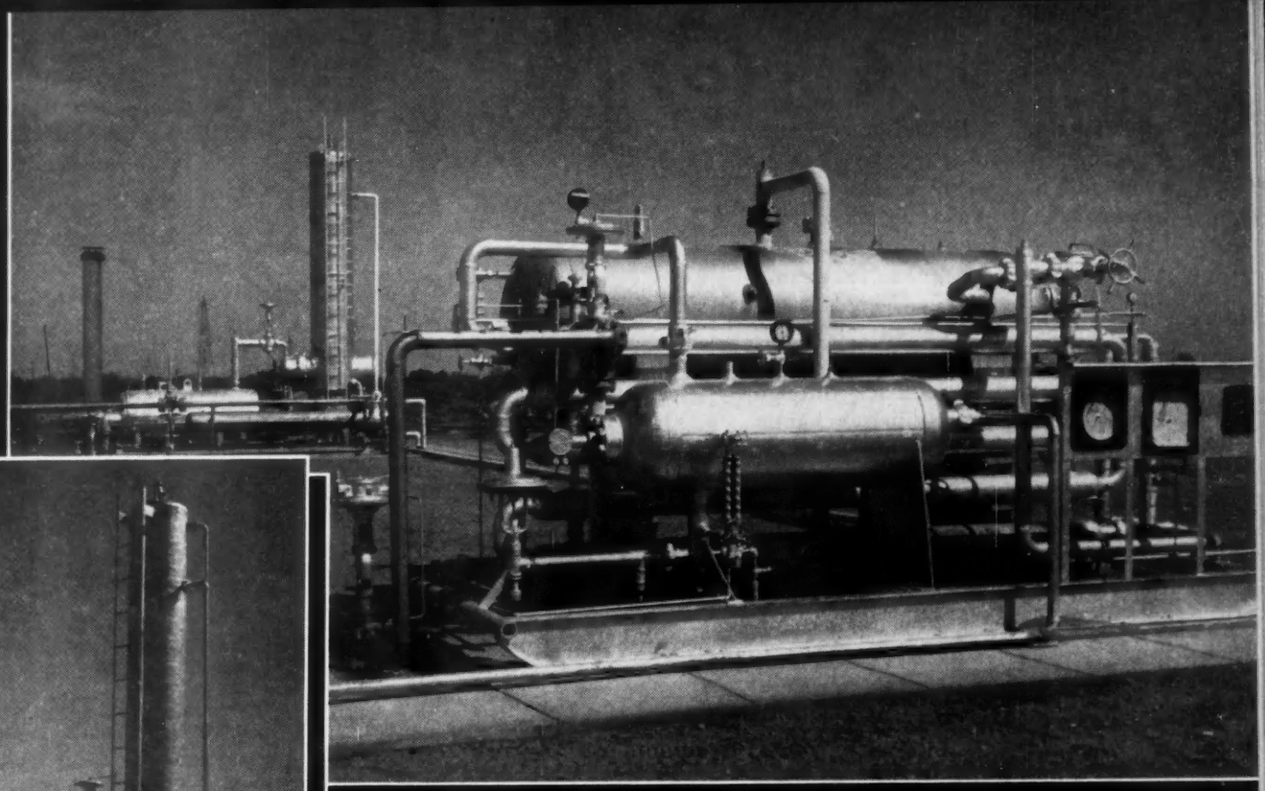
Rapid progress had been made toward ways and means of automatic custody transfer at lease tanks. Some of the systems studied are:

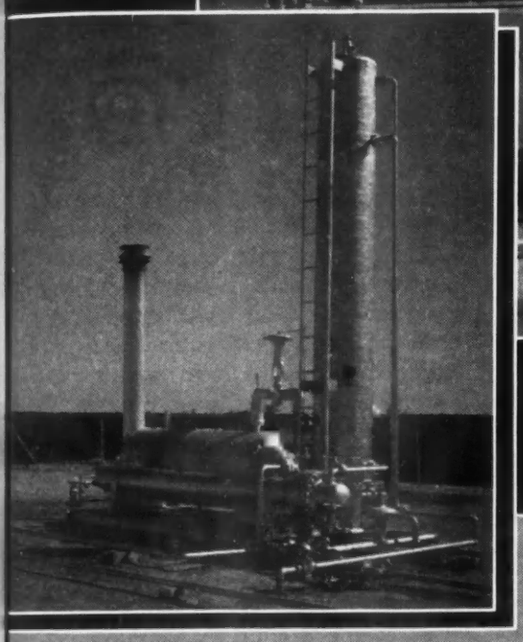
1. Positive Displacement Meters. This seems to be the simplest, most direct, and most economical way of automatic gaging. However, as is often the case, the most attractive is not always the most satisfactory solution. Metering is adequately covered by API Code 1101, and may be used if mutually agreeable. Metering simply has not caught on because too many people have had sad experience with attempts to meter crude oil.

2. Bulk Weighing. This method consists of a tank located on the platform of a beam-balanced scale. When the tank is filled with "ex" pounds of oil, the beam-balance trips a valve that shuts off flow of oil into tank and opens the valve that allows the oil to flow into the pipe line; "x" pounds of oil being dumped into the pipe line each time. This method eliminates some of the problems of manual gaging such as temperature correction, shell incrustation, etc. However, it leaves the final settlement to an accurate measurement of the oil gravity. This is not considered desirable, and the over-all accuracy of this method is so far considered unsuitable. Our industry is geared to gallons and barrels and it would be a tremendous chore to change to a weight basis. There are, however, some specific and isolated cases where weight measurement has attractive advantages.

3. Metering Tanks. This seems to be a new approach to the automatic gaging problem. It simply automatically fills a regular lease tank and then dumps it into the pipe line. To make this system satisfactory, several problems are apparent. Let's look at them one at a time:

Quality Sampling, i.e., Gravity and BS&W. These measurements can be obtained satisfactorily from a sample accumulated by an automatic sampler. Such samplers have been in use for several years and are currently being codified by a committee of API.





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There is really no problem here, only application of established practice in a way that is mutually agreeable to seller and buyer. No pipeliner wants to learn next week that a tank of fluid, half water, has been dumped into his system. He should be protected against such conditions by a capacitance probe in the filling line of the metering tank. This can be used to monitor the stream and direct back through the treating system any unmerchantable oil offered to the metering tank.

Quantity Measurements. Temperature recording thermometers are approved and codified by Code 2500, 1954 Edition. So here again, we only have to apply the approved and established practice.

Volume is the heart of the problem. Gravity, BS&W and temperature are important, but they are only incremental adjustments to this one basic measurement. The writer is sure the volume of tanks can be accurately determined by several methods. Let's look at just one simple and practical method.

Assume we have an ordinary field tank 10 feet x 12 feet. To adapt it to automatic gaging, accurately cut two slots each two inches by 12 inches in the shell, parallel to the bottom. The low slot one foot above the bottom, the other one exactly eight feet above the lower one. Cover each slot with a regular cleanout box. Connect the pipe line to the lower portion of the lower box and the tank overflow to the lower portion of the upper box. Install three float switches, one in each box three inches below the slot and the third one in the tank six inches above the upper slot. Install motorized valves on the pipe line, overflow, and filling lines. Wire the float switches and valves to follow this sequence. Starting with an empty tank, valve one is open, valves two and three are closed.

1. Fill the tank until float one raises and causes valve two to closed.
2. Have a time delay for weathering and settling as agreed upon by producer and pipe line.
3. Open overflow valve two and drain back into the producer's system all oil above upper slot.
4. When float two lowers it will close valve two.
5. Record the tank temperature.
6. Open valve three and allow the oil to drain into the pipe line down to lower slot.
7. When float three lowers it will close valve three and the tank is ready to refill.
8. Record one run.

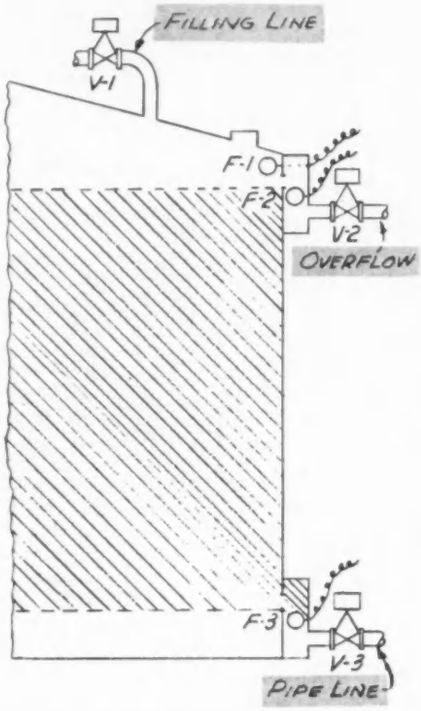

FIGURE 1

9. During drain out time, the automatic sampler would collect a portion of the oil as it flows into the pipe line.

Each gross run will be exactly the capacity of the tank between the two slots, shaded area as shown in Figure 1.

Next problem is to count the number of runs, or dumps. A counter can be attached to the pipe line valve. They can also be checked on the recording thermometer chart, and/or recorded by a low range recording pressure gage, connected directly to the shell of the tank at the lower slot level. It would record crests and troughs as the tank was filled and emptied.

Most pipeliners will say they should have an over-riding control that would schedule the runs into their pipe line. In many cases, this will be a necessity so that they can prorate their pipe line space equitably to all producers in their system, whether on automatic or manual gaging basis.

For protection of both producer and pipe line, all control mechanisms, such as micro-switches, time-cycle controls, recording devices and automatic sampler should be installed in a tamper-proof, sealable housing. At the end of a run term the representatives of the producer and purchaser would meet at the battery, open the housing, and from the records, make out a ticket covering all oil delivered to the pipe line for that run term.

Savings. Estimates of the length of the run term vary from a week to a month, and it is expected that in actual practice the run term will be cut or sized to fit conditions. In any case, it will certainly allow both pipe line and producer to expand the amount of work that can be adequately supervised by his personnel. The metering tank can be run and immediately refilled at any specified time and thus should replace several regular production tanks. Two such tanks that could alternately fill and empty could run a constant stream to the pipe line. With either one or two tanks, pipe lines should be able to smooth out their line-load factors in their gathering systems. In sour crude areas this method would surely reduce personnel hazards. It will not stop corrosion of production tanks, but it will reduce the number of tanks exposed. —**The End**

About the Author

RUDOLPH A. HAMILL was born in Delaware, Okla., and graduated from Southeastern State Teachers College in 1931 with a B.S. degree in mathematics. Before completing his education he worked in the oil fields around Seminole, Okla. In 1933 he joined Stanolind Pipe Line Company, now Service Pipe Line Company, as a gang hand and filled many posts until he became a gager in 1943. Since then he has specialized in this work and is now chief gager for his company.

Allows Controlled Fracturing

By JOHN N. SCHUELKE
WORLD OIL Staff

AN INGENIOUS liner setting tool developed in the field for setting 1¼-inch liners has enabled Stekoll Petroleum Company to perforate and fracture sands in the old Corsicana Shallow field with highly encouraging increases in production. Dual-fracturing through 2-inch casing is another technique this operator has developed for better control of the fracturing of the upper and lower sections of the producing formation.

Stekoll Petroleum Company operates over 200 wells on a 2000-acre lease in the north end of the Corsicana Shallow field. Eleven of these wells date back to 1894, and at the time of workover had declined to approximately one-half barrel of oil per day. The remainder of the wells have been drilled and completed in the last 4 or 5 years as part of an extensive development program. These later wells were completed by setting 2-inch tubing or line pipe string on top of the pay and cementing 300 feet up from the bottom. Only 300 feet of the 2-inch casing is cemented because injection of the Woodbine water at 120° F. made it necessary to allow freedom of the pipe for expansion. Recently drilled wells were incapable of production until fractured. After fracturing, the production from these wells has been as high as 5 to 30 barrels of oil per day.

Production in the Corsicana Shallow field occurs from the Corsicana shallow sand of the Wolfe City Series at depths between 970 and 1100 feet subsurface. Gross pay thickness is approximately 60 feet with electric logs

FIGURE 3—Two perforating guns are being prepared for shooting. Note pewter weight and the spacing of the charges on the prima-cord. Aileron wire carriers are two small to distinguish in photo.

of the wells indicating a 5 to 7-foot shale interval dividing the top 12 to 15 feet of sand from the lower 40 feet of sand. The upper section is thought to be more loosely consolidated, with higher porosity and permeability than the lower section and under fracturing pressures it will break down under less pressure than the lower section, making it doubtful if the lower section benefited from the fracture treatment.

Fracturing Initiated. With the advent of successful fracturing treatments Stekoll Petroleum, along with many other operators, was faced with the prospect of trying to fracture open hole with little or no control, or devising some new means of setting a liner through 2-inch pipe to obtain control. Here the operator really had two problems: The old wells were cased with 4-inch or larger pipe to the top of the pay and it was now possible to set 2-inch casing to bottom, but how could the fracture treatment into the two sections of the pay be controlled? Secondly, the newer wells completed only 4 or 5 years before had 2-inch line pipe cemented in place on top of the pay. The problem of completing these wells so that controlled fracturing jobs could be performed was tackled by the field personnel with the aid of well servicing companies.

Dual Fractures. The old wells were recompleted by setting a 2-inch casing string on bottom and cementing it in place. The bottom pay interval was perforated using a small shape charge that would pass through a $1^{25}/_{32}$-inch pump seat. This lower interval was then fractured using 3000 pounds of sand and 37 barrels of lease crude for mixing. Then the upper interval was perforated and a 1-inch stand pipe long enough to reach from the bottom of the well to above the lower perforations was dropped in the well.

A 2-inch rubber plug (Figure 1) was pumped down the 2-inch casing until a drop in pressure indicated that the plug had passed the upper perforations. The upper formation was then fractured. A collar catcher with the bottom sharpened and notched was run in on 1-inch pipe and rotated to drill-up the rubber plug, slip over the collar on the 1-inch stand pipe and retrieve it. The well was then ready to place on production.

1 ¼-Inch Liner. The wells that were permanently completed 4 or 5 years ago by cementing the 2-inch line pipe on top of the pay posed a greater problem for controlled fracturing. A novel little tool was fabricated on the lease to facilitate running and cementing a 1¼-inch liner (Figure 2). A spear blade was welded to the end of a short length of ⅝-inch sucker rod and a ball and seat cage was inverted and welded to the other end. A short ¾-inch nipple was welded to the other end of the cage and a short length of 1¼-inch pipe was welded to the outside of the seat so that all circulation would occur down the ¾-inch and the 1¼-inch would be sealed off. A left hand thread was cut on the top of the ¾-inch nipple and a right and left hand collar was attached. As 1¼-inch collars would not pass through the 2-inch line pipe the sections forming the liner had to be welded, like plain end casing, while running in the hole. The ¾-inch run-in string was made up at the same time. When the liner touched bottom it was picked up a short distance and dropped on bottom so that the spear point would be imbedded in the bottom of the well.

The liner was cemented in place by cementing down the ¾-inch string and a ¾-inch plug was pumped down on top of the cement and bottomed on the ball seat. The ¾-inch pipe was then rotated to the left and backed-off while the liner was prevented from rotating by the blades of the spear imbedded in the well bottom. Water was circulated down the ¾-inch string in case any cement had come around the top of the liner. The servicing unit could then be moved off location while the cement set. The liner can be perforated and the formation fractured without the need of a servicing unit.

Injection Rate. The operator determined by actual field tests that the maximum rate at which the sand-oil mix can be pumped through a ½-inch hole with fracture equipment is 1.2 barrels per minute. The entire length of pipe opposite the pay interval is not shot, but if, for example, five shots were used one foot apart, an injection rate of at least 6.0 barrels per minute would be required so that all five holes would have near maximum through-put. By spacing these holes a foot or more apart they hope to obtain a good multi-frac job rather than having closer spaced holes contribute to one large fracture and the through-put of some perforations would be inadequate and ineffective.

Six thousand pounds of sand and 75 barrels of lease crude are used for these fracture jobs. Here, another technique has been developed that has given better results for the fracture jobs. The frac-job is three-staged. One batch of 2000 pounds and 25 barrels of oil is mixed and squeezed into the formation and flushed with 20 barrels of crude oil and the pressure is held for 10 minutes. This same procedure is followed for the second and third stages. By letting each stage set 10 minutes, it is hoped that the pressure will have time to equalize throughout the fracture area.

Production Increased. The older wells before fracturing were down to ½-barrel of oil per day while new wells were practically incapable of production before fracturing. After fracturing, these wells are making 5 to 30 barrels of 38-degree gravity oil per day. A regular insert type pump with a blind cage on top is used to pump these wells while 1-inch pipe is used as both rods and tubing.

The newly developed perforating gun that has made possible the 1¼-inch completions is unique in the fact that it does not require a bulky carrier but is composed of two strands of $^1/_{32}$-inch aileron wire that has the charges spaced and crimped in place (Figure 3). Weight for lowering is provided by a pewter metal weight that is destroyed in the hole with little or no ill effects to the well other than a slight fill-up at the bottom of the hole. Well head equipment for the perforating is a sheave welded to a 2-inch nipple, very similar to a wire line head. This makes it possible for one man to perforate a well without assistance.

By the development of these unique operating procedures and equipment Stekoll Petroleum is realizing economic production gains in excess of what could be expected with open hole fracturing. The workover costs are relatively low and service units only are required for pulling and running pipe. —**The End**

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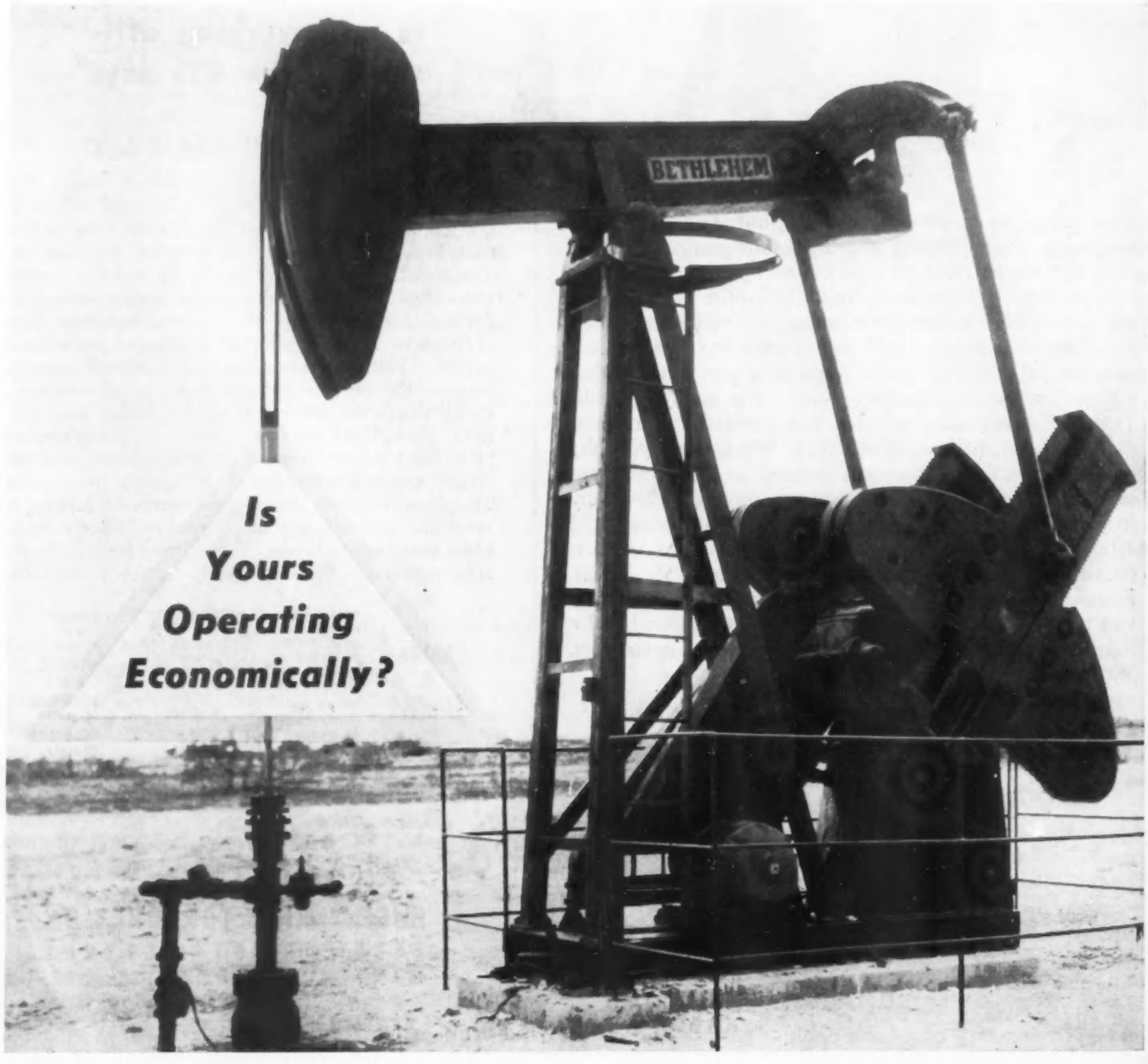
"Good will" is the disposition of the pleased customer to return to the place where he has been well treated.
—U.S. Supreme Court

BUILDS PUMPS THAT BUILD GOOD WILL

Economy Practices on Electrified Leases

By **REX BROWN**
Southwestern Public Service Company
Lubbock, Texas



. . . these tests show how to properly handle electrical power on a lease. The results: increased production and decreased power and maintenance costs.

A MOST IMPORTANT aspect of electrified lease economy is the proper handling of electrical power on the lease itself.

For a certain load such as a beam pumped lease, several factors must be considered in designing an electrical power distribution system. In addition to the physical design, electrical characteristics must be considered. One of the most important is the power factor which is a ratio between the apparent power and the actual power being required by an electric motor.

Apparent power is calculated from the actual amps and volts going to the motor while the actual power is the amps and volts that are doing the work.

The problem is to eliminate wattless amps from lease distribution lines so maximum power can be delivered to the well over minimum sized wire, or in many cases so additional wells could be pulled from an existing system without the necessity of rebuilding to take care of the added load.

Wattless amps load the systems and cause heat losses on the lines just as do power amps. The problem is solved by installing an individual capacitor of appropriate size connected on the load side of the starting equipment at the well. The electrical characteristics of the capacitor is such that it supplies the wattless current to induction circuits such as the induction motors used in oil field pumping. Thus, by having equipment that will supply the necessary wattless current at the load, it relieves the lines on the lease of the burden of handling it.

The reduction of the total current on the system actually will improve the voltage level on the lease, reduce the required transformer rating and distribution conductor size as well as reduce power costs and make a more economically operating lease.

The importance of capacitors for a more economically operated lease is exemplified by the following tests.

This first test was made in the Levelland field on nine wells using ten horsepower high torque motors and four KVAR capacitors. Simultaneous operation of the well units using a 75 KVA transformer bank. (See Table 1)

TABLE 1

Capacitor KVAR	Trans. Volts	Extremity Volts	Trans. Amps.	Trans. KW
0	475–480	420–450	85–105	30.2
36	475–482	445–475	45–65	29.37

With no capacitance connected, the extremity voltage varied from 420 to 450 volts, the transformer amperage varied from 85 to 105 amps with an actual KW demand of 30.2 KW. After proper capacitance was installed, the extremity voltage increased to range between 445 and 475. The transformer amperage decreased then varied between 45 and 65 amps and the KW demand actually decreased at the transformers to 29.37 KW. A decrease of about 2.75 percent in the lease power consumption.

A more impressive test proving the economics of applying capacitors to individual lease use was conducted on a 13-well lease in the Garza field. This lease was equipped with 7½ horsepower motors, four KVAR capacitors, and a 45 KVA transformer bank. Tests were made with no capacitance and then with proper capacitance. (See Table 2.)

The installation of proper capacitors increased the extremity voltage from 380/430 to 420/480. The thermal, or average, secondary amps were decreased from 100 to 43.2 and the primary KW input to the lease decreased from 35.3 to 30.5 KW, or a decrease of 15 percent in actual power input to the lease.

The economical use of electric power may be emphasized by reviewing some graphic tests made on pumping wells in two different fields. In these tests only two factors were involved: running a well out of balance; running a well after it is pumped off, or both.

By a systematic study of the instantaneous current in each phase at the well, it was determined the problem was not only balancing the well properly, but when to do the balancing.

A thermal type graphic demand meter with a 48-hour chart was used. The thermal meter was selected because of its simplicity, sturdiness, and because it presents no trouble with the indicator swing that is always present in magnetic instruments when testing oscillating loads such as individual beam pumping units. The KW meter was chosen over the ammeter to provide an indication of the change in power used by the well under operating conditions. Because of the electrical characteristics of an induction motor under varying loads, the thermal ammeter would not give a true picture of the power input to the well. Also, by integrating the KW chart, the KWH consumed can be determined. Since most oil field distribution in this area is 480 volts, a

TABLE 2

KVAR	Trans. Volts	Extremity Volts	Thermal Secondary Amps.	Power Factor	Pri. KW Input	Primary Volts
0	470/490	380/430	100	50%	35.3	4080
52	500	420/480	43.2	90%	30.5	4120

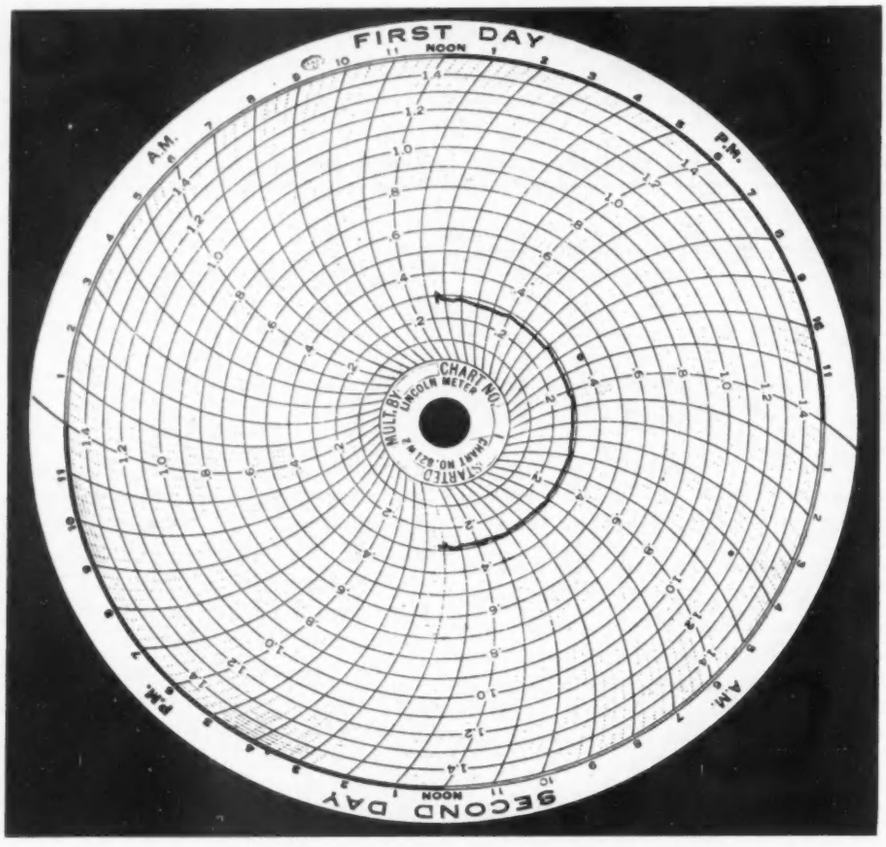


CHART 1—Troubled well in Seminole field. Continuous 24-hour operation used excessive electric power. Maximum demand was 6.8 kilowatts. Energy cost per barrel was 3.28 cents.

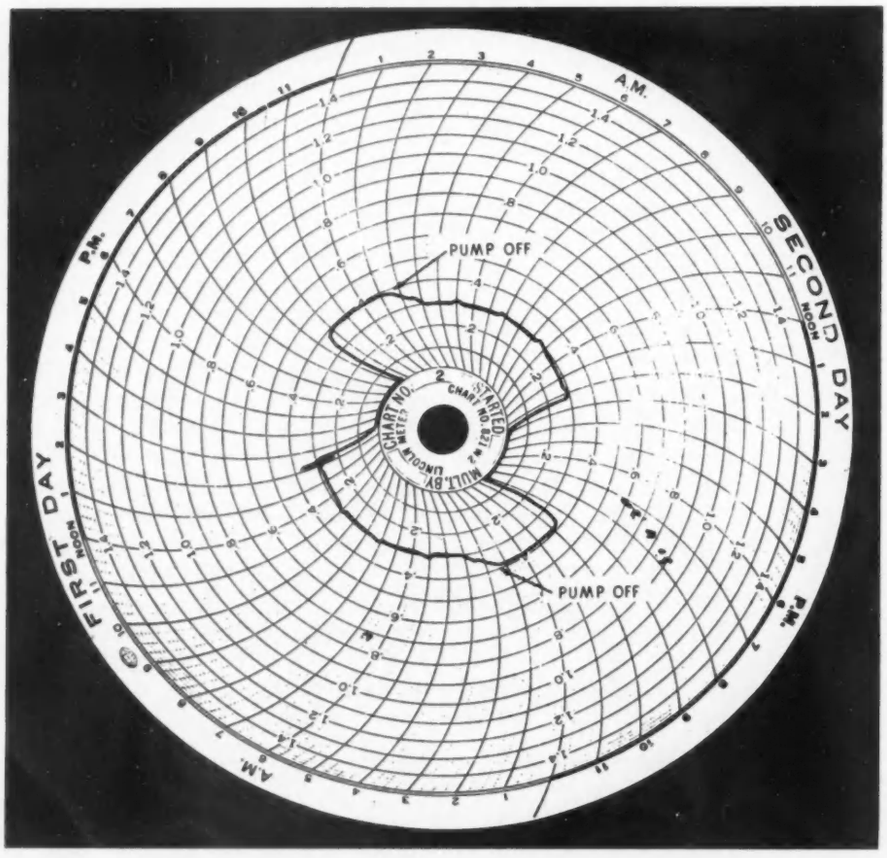


CHART 2—First trial to balance pumping cycle. Well was operated for 17 hours, then off for 7 hours. Well began to pump off after four hours. Maximum demand was 9.5 kilowatts on this 48-hour chart.

480 volt KW meter was selected and two multiple tap current transformers were mounted in a box with the meter for ease in connecting to different sized loads.

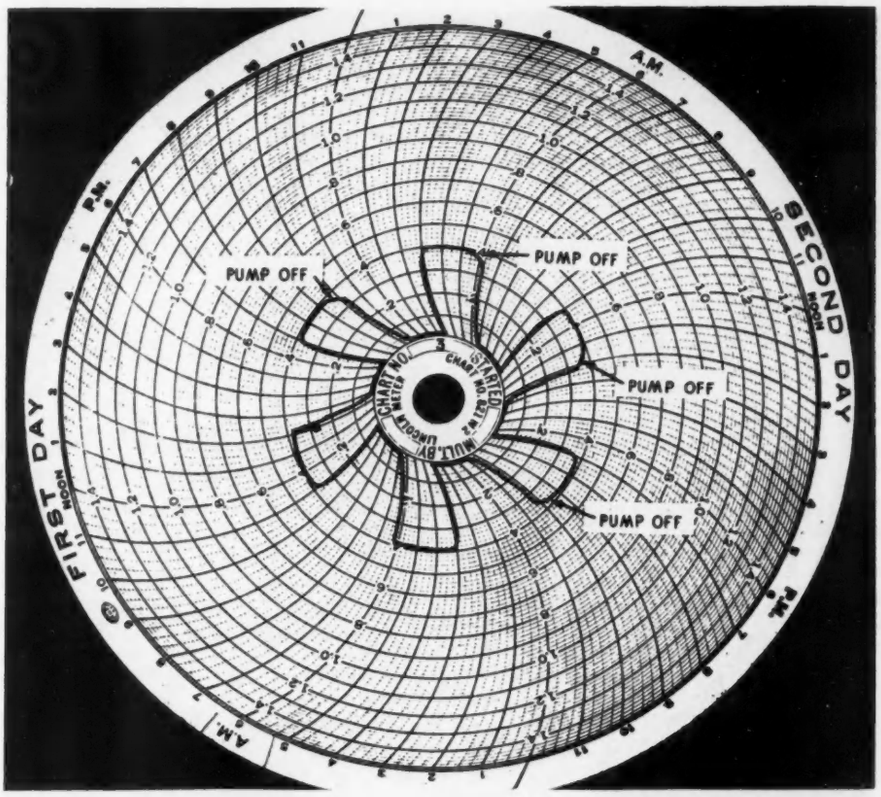
The instrument was placed on a 20 hp electrified well in trouble in the Seminole field, where little gas was present. This well, referred to as Test Well "A", was being pumped around the clock, and Chart I, Test No. 1A was made under normal operation. By integrating the KW chart, the energy cost per bbl. of oil amounted to 2.34 cents in the 24 hour operation, with a demand of about 6.8 KW, as shown under the tabulated results of Test Well "A". The producer cooperated and changed the time settings as requested.

For the first trial, the time clock was set for 17 hours operation and seven hours off, as indicated in Chart 2, Test No. 2A. From a close observation of KW demand Chart 2 and production gaging, it was determined that the well had begun to pump off after about four hours and then for 13 hours the well pumped much less oil. (Note pump off point marked on the KW charts). Even though the demand was lower, the KWH requirement per barrel of oil was much higher during this 13-hour period because of loss in efficiency of the equipment, part of which was due to the fact that the balance of the pumping unit was thrown off when the oil to be lifted decreased.

This loss in efficiency tends to increase the demand due only to the operation of the unit and the pump itself. This is more than offset, however, by the fact that there is much less oil to be lifted, which means less actual work to be done and thus a smaller power requirement as is indicated on the KW demand charts. This made it more expensive to lift each additional barrel of fluid. The next setting, it was determined, could logically be 3½ hours on and 4½ hours off. With this time setting, the well began to pump off at the end of 2½ hours, as is indicated on Chart 3, Test 3A.

However, after about 36 hours of this cycling, the build up in production was such that the well ceased to pump off at any time, as is indicated in the latter hours of Chart 3, where there is no pump off point. (KW demand remains constant). In the final

CHART 3—Second setting was 3½ hours on, 4½ hours off. Well pumped off at end of 2½ hours. Maximum demand was 9.5 kilowatts on this 48-hour chart. Power costs were 2.16 cents per barrel.



analysis of this particular test, the settings were 3¾ hours on and 4¼ hours off, as shown on KW Chart 4, Test No. 4A. With these settings, the well never pumped off and the unit was in balance at all times. At the beginning of this series of tests, the well was pumping approximately 68 barrels of oil per day at a cost of 3.28 cents per barrel for electric power. At the end of the tests, the well was pumping approximately the same amount of oil at a cost of 2.10 cents per barrel, a reduction of 36 percent.

The well was producing at a high rate, and the unit was in balance during the entire 3¾-hour operating period. In this particular case, the stroke was not changed. The well was set at 17 strokes per minute—54-inch strokes with the fluid testing 5 percent water. (See Table 3.)

These data are representative of many time settings that were made on this particular well. No spectacular production results were achieved, but operating time was cut to less than half and electrical expense was reduced 36 percent.

TABLE 3—Tabulated Results from TEST WELL "A"

TEST	TIME CYCLE		Barrels Oil	KWH per Barrel	Barrels per Hour	Cost* per Barrel
	Hours On	Hours Off				
No. 1A	24	0	68.35	2.34	2.85	3.28¢
No. 2A	17	7	66.63	2.03	3.9	2.79¢
No. 3A	3½	4½	64.41	1.55	6.18	2.16¢
No. 4A	3¾	4¼	69.03	1.53	6.14	2.10¢

* Based on Energy Charge of 1.375¢/KWH.

The most interesting test from a graphic standpoint was conducted on a well in the Cedar Lake field powered by a 15-hp motor with 20 34-inch strokes per minute. The test was kicked off by checking the well under 24 hour continuous operation, shown in Chart 5, Test No. 1B. Under this condition of operating around the clock, the results show a picture that, even at a glance, looks bad. In this test referred to as Test Well "B",

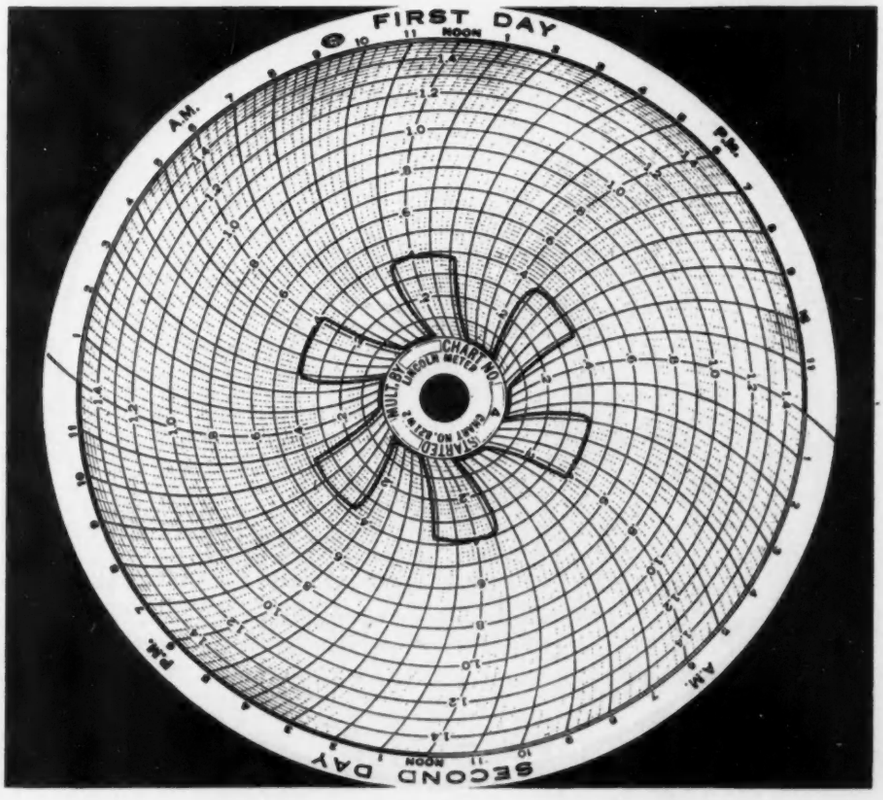


CHART 4—Final time cycle was 3¾ hours on and 4½ hours off: Maximum demand was 9.6 kilowatts, but production increased from 68.35 barrels of oil (plus 5 percent water in both cases). Electric power costs for this setting was 2.10 cents per barrel, a reduction of 36 percent over continuous operating cycle.

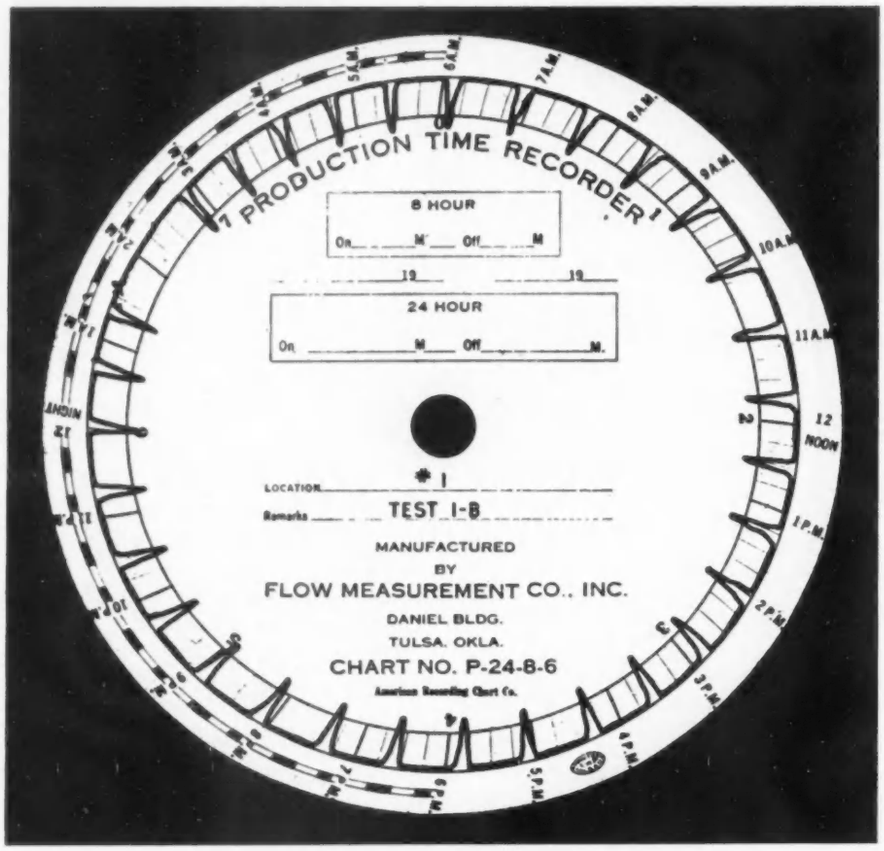
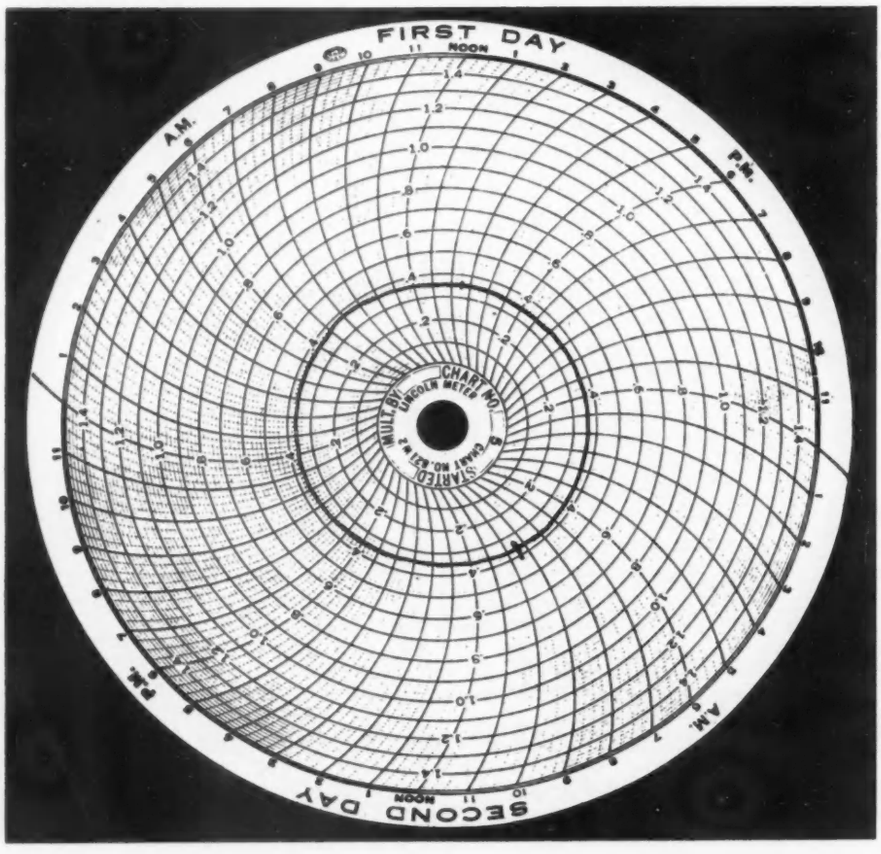


CHART 5—Interesting case in Cedar Lake field, tested first under regular 24-hour operation, using 48-hour charts on wattmeter (below). Maximum demand was 3.8 kilowatts. Production: 31 barrels fluid per 24 hours. Power costs: 3.89 cents per barrel. Production time recorder chart above indicates time separator dumps.



a production meter was used instead of gaging. This was very beneficial to the tests, since no water was present. In this initial test, the oil pumped amounted to 31 barrels with an energy use of 90 KWH. This means an energy cost of 3.89 cents per barrel to operate this well.

In Test No. 2B, a time setting of 5 hours on and 7 hours off was used, as indicated on Chart 6. This means 10 hours pumping time per day as compared to the original 24. It is interesting to note in Chart 6 that the rate of production and the rate of electric power used (KW demand) follow the same pattern. The well produced 34 barrels of oil with the use of only 46.5 KWH, or the well produced 34 barrels of oil at a cost of 1.88 cents per barrel for electric service. Even with this improved operation, the demand Chart 6 indicated that the well had begun to pump-off after about two hours.

This was verified by the production chart. On the following test a time setting of 2 hours on and 4 hours off was used on Test No. 3B. This was a 48-hour test. As expected, there was additional improvement. In this case, 38 barrels of oil was produced at a cost of 1.375 cents per barrel. The production was up almost 25 percent over the original setting and the cost of energy was less than half of what it was before the tests were started.

These results prompted additional study, as shown in Test No. 4B. In Test 4B, the time was left at 2 hours on but the off time was reduced to 2 hours. The production was increased again and was now at a rate of 44 barrels per day. During this 24-hour period, energy was used at a rate of 1.09 KWH per barrel and production was at a rate of 3.66 barrels per hour.

This is a decrease in the production per hour of operation and can be easily explained because the production and KW charts indicate that on each cycle the well had begun to pump off. The pumping time was reduced the following day to 1½ hours on and increased the off time to 2½ hours, shown in Test No. 5B. The result of this test was an increase in the cost per barrel as well as decreased production.

Even though costs were less as far as purchased power was concerned

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- Bolted gland stuffing box with Teflon packing.

- Stainless steel clear view travel indicator.

- Spring ranges: 3 to 15 psi; 6 to 30 psi.

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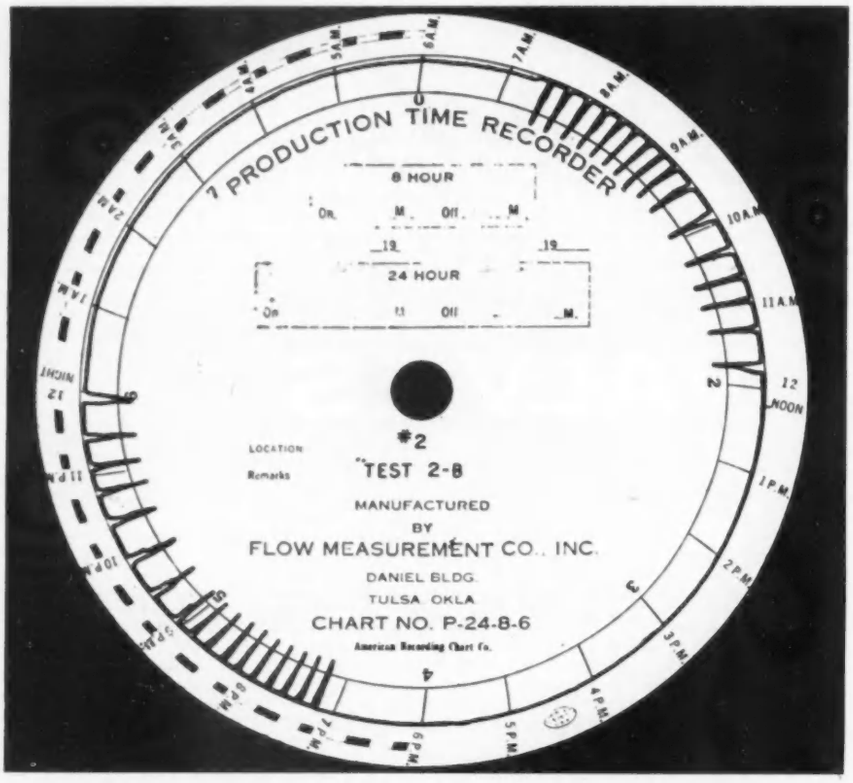

CHART 6—Operating cycle on preceding case was changed to 5 hours on, 7 hours off. Maximum demand was 6.8 kilowatts on a 24-hour chart. Production increased from 31 barrels to 34 barrels at a power cost per barrel of 1.88 cents.

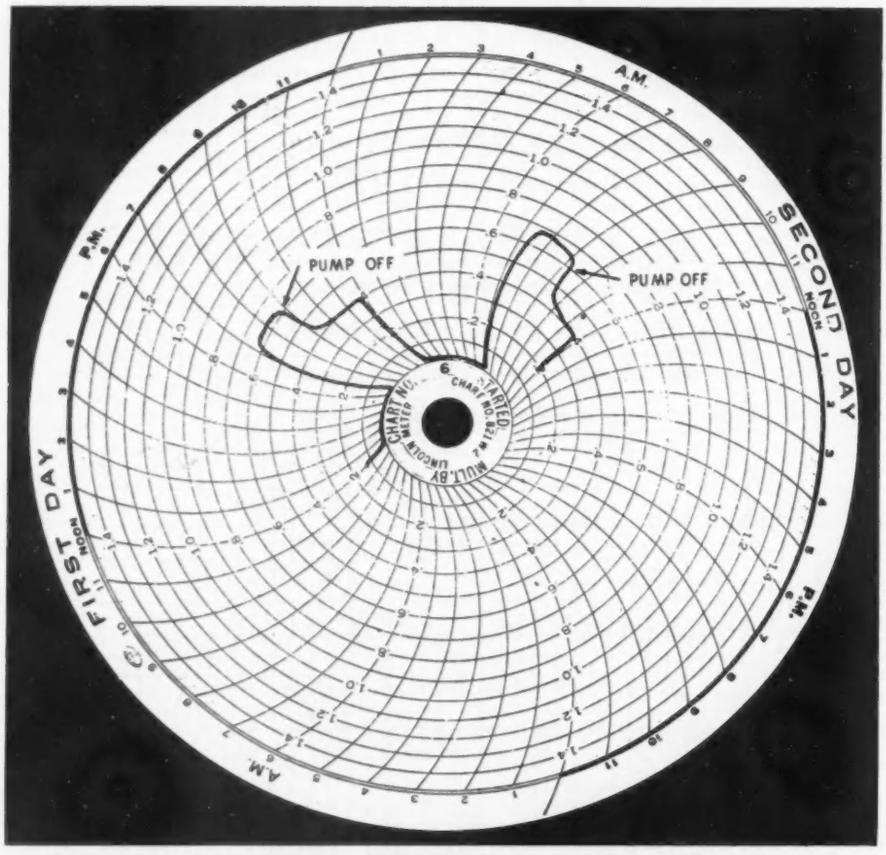

TABLE 4—Tabulated Results from TEST WELL "B"

TEST	TIME CYCLE		Barrels Oil	KWH per Barrel	Barrels per Hour	Cost* per Barrel
	Hours On	Hours Off				
No. 1B	24	0	31	2.90	1.29	3.89¢
No. 2B	5	7	34	1.37	3.40	1.88¢
No. 3B	2	4	38	1.00	4.75	1.375¢
No. 4B	2	2	44	1.09	3.66	1.505¢
No. 5B	1½	2½	35	1.58	3.89	2.18¢

* Based on Energy Charge of 1.375¢/KWH.

with time settings of two hours on and four hours off, the operator selected the time settings of two hours on and two off because of the greater production. The final analysis of these tests amounts to an increase in production of from 31 to 44 barrels per day. This is a 42 percent increase with the energy cost being reduced 60 percent. (See Table 4.)

These data are representative of many time settings that were made on this particular well.

Advantages. It is felt that the main advantages of a properly planned time cycle schedule for marginal wells with low G.O.R. are:

1. Increased production
2. Reduced power operating cost
3. Lowered maintenance through balanced operation and reduced operating time
   - (a) Prolonged unit life
   - (b) Reduced rod trouble
   - (c) Reduced stuffing box trouble
   - (d) Reduced pump trouble
   - (e) Eliminating pounding
   - (f) Reduced servicing costs
4. Increased pumper convenience and efficiency
   - (a) Can pump more wells
   - (b) Reduces pick-up mileage
   - (c) Reduces stuffing box clean-up problems
5. Tends to conserve formation gas because fluid buildup maintains back pressure on the formation.

ACKNOWLEDGMENT:

Based on a paper presented at the West Texas Oil Lifting Methods Short Course sponsored by Texas Technological College, Lubbock, Texas.

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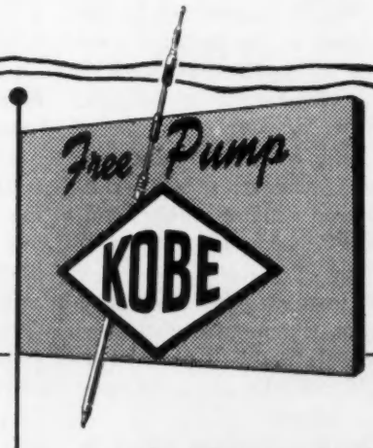

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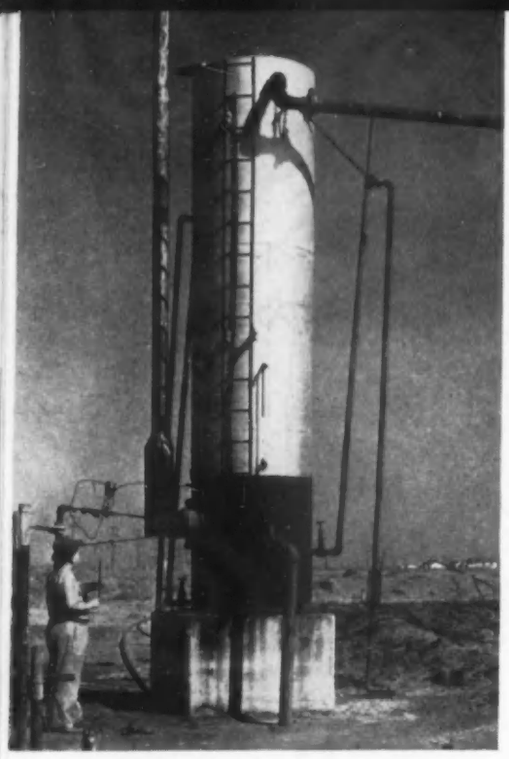

FIGURE 1—Oil treater which was metalized with lead in 1946 operated continuously for more than 75 months without leak or loss of metal. Lease was abandoned after the 75 months.

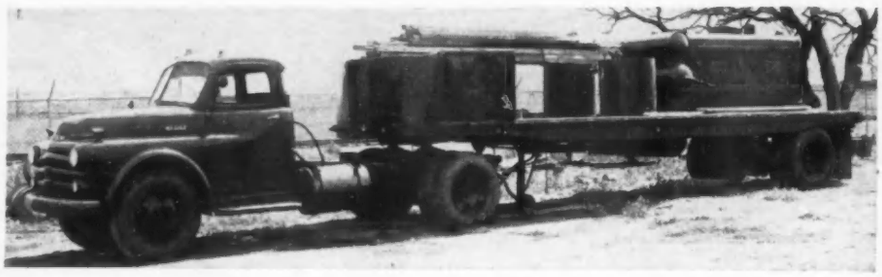

FIGURE 2—Portable unit used for sand blasting and lead spraying of oil field installations to prevent corrosion.

New Way to Stop Corrosion

Coating steel with lead without heat.

By **ANTHONY GIBBON,** WORLD OIL Staff

LEAD AND STEEL are bonded together by molecular attraction in a new method that is proving effective in stopping corrosion of oil field installations. This unusual technique involves the application of lead as metal to steel without the use of heat. A piece of steel, when so treated, shows all the characteristics of lead when scraped with a knife.

The process of metalizing with lead to control and/or to eliminate corrosion, was first developed for an industry unrelated to the petroleum industry. Since then, however, it is being used extensively in oil field installations to prevent corrosion of tubing and pipe, both inside and out, tanks, treaters, gasoline plants, refineries, spray and cooling towers and structural steel which are subject to corrosion.

In order to treat the steel it is necessary that the metal be cleaned properly to a 100 percent bright surface. This is done by portable sand blasting equipment.

The cleaning operation must be done in clear weather at relatively low humidity to prevent accumulation of any oxide that would retard the bonding the lead coat to steel. The lead is applied with specially-designed equipment at atmospheric temperature.

The material consists of finely divided metallic lead mixed in a volatile wetting agent to permit spraying. This spraying is done at extremely low pressure with a high volume of air to carry the wet material to the surface to be protected. The wetting agent evaporates out in a matter of minutes, leaving the metal deposited on the surface. This spraying operation is repeated twice (making three applications) leaving a deposit of lead as metal of approximately 14 pounds to 80 square feet of surface, or an approximate thickness of 10 mils.

Field applications. Following are some results in preventing corrosion by the application of the method:

On a string of tubing in a producing well where the life of normal tubing was less than 12 months, a replacement string was treated by the process. At the end of four years, this string of 170 joints showed a loss of only two joints on the bottom of the string at the collars.

A tank handling sour crude that was put in service in 1942 was treated subsequently and is today one of the four original tanks remaining on the lease, the other three having been replaced twice since 1942.

A water disposal system installed near Cement, Okla., consisting in part of a tub made of two rings of an 80,000-barrel tank used to aerate Arkuckle water before injection, shows no corrosion or leaks after several years following application of the method.

A water-flood in Greenwood County, Kansas, put in service late in 1943, with piping ranging from 2-inch to 5½-inch, protected inside by this process, shows no leaks or loss of pipe after seven years service.

The treater shown in Figure 1 replaced a like treater which required more than 300 plugs to stop leaks in less than one year. This replacement treater was installed in 1946, protected inside and outside with the process, and operated continuously for more than 75 months without a leak or loss of metal. This lease was abandoned in 1952 and had been producing more than 90 percent water with an excess of 3000 grains hydrogen sulfide. A similar treater on a nearby lease, the bottom ring of which was made of quarter-inch steel, collapsed in 49 days. The replacement protected inside with this process and installed in 1947, is still in operation without leaks.

The piping in a cooling tower at a gasoline plant located in the Gulf Coast area was lost from external corrosion in nine months. Pipe replacing this loss was protected externally by this process and has been in service more than eight years without cost in replacement or maintenance. —**The End**

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*1 mil=.001 inch. A corrosion rate of 216 mils per year means that the corrosive attack, if uniform, would have corroded away the entire surface of the metal to a depth of .216 inches in a year. However, the real danger of high corrosion rates, as the coupon shows, is the much deeper and faster penetration occurring at localized areas.

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Acid Treatment of the Spraberry Formation

Spraberry cores have responded better to treatment with sulfamic acid than they have to standard HCl treatments.

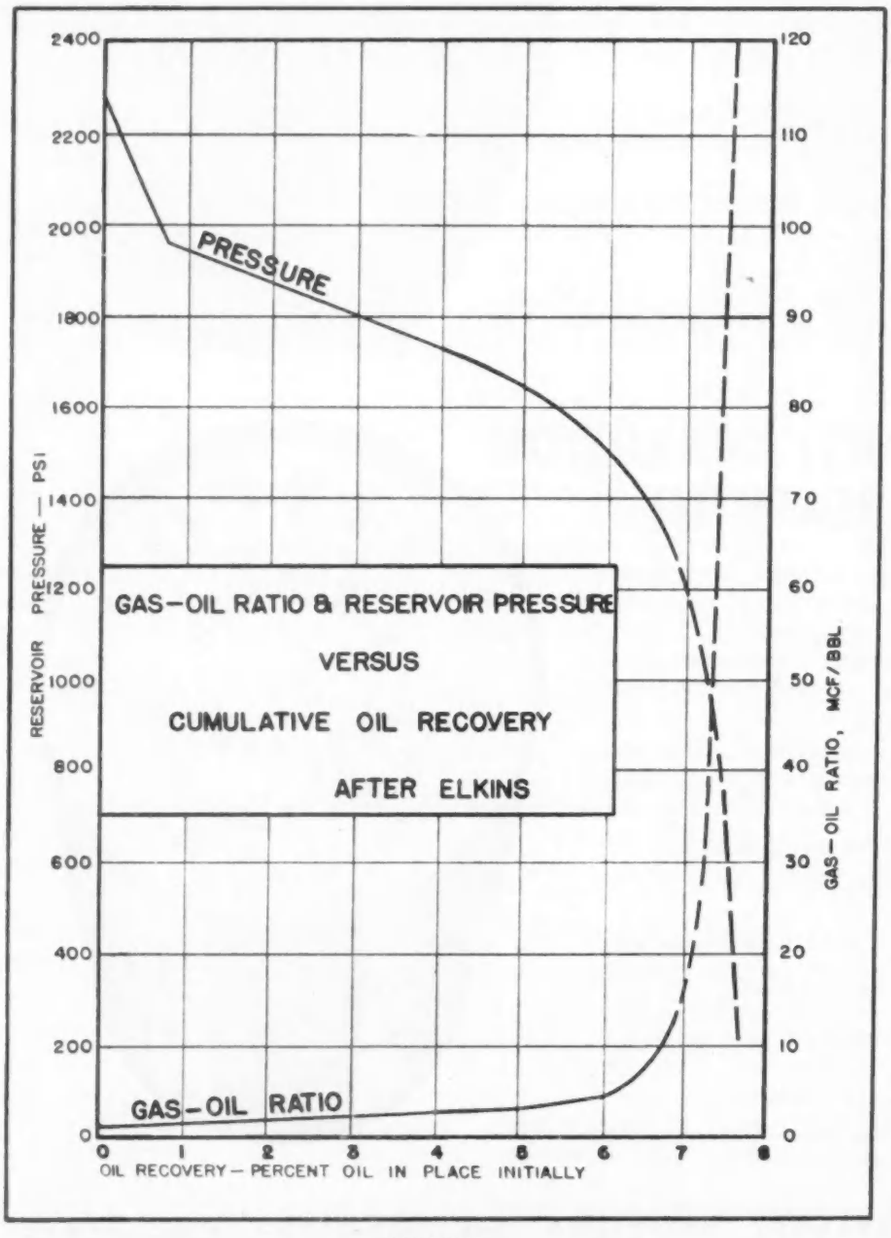

FIGURE 1

By F. W. JESSEN and GEORGE T. KARPOS,
Department of Petroleum Engineering,
University of Texas,
Austin

LABORATORY EXPERIMENTS conducted at the University of Texas on Spraberry cores have shown that sulfamic acid, a slow acting acid, produced larger permeability increases than were obtained with the commercial hydrochloric acids. Permeability increases of 17.3 percent were obtained with sulfamic acid indicating that possible field trials are warranted.

Reservoir Characteristics and Performance. The unique reservoir characteristics and performance of the Spraberry formation have made it a controversial problem in development and exploitation. The sands are closely packed, tightly cemented, and are of low porosity (7 to 20 percent) and extremely low permeability (0.001 to 1.0 md).

An outstanding feature of the formation is the inherent system of interconnected vertical fractures, some known to extend more than 100 feet vertically and about one-half mile or more horizontally.[2] It is estimated[3] that 97 percent of the flow capacity of the Spraberry arises from the fractures, and only 3 percent from the matrix, hence it must be concluded the Spraberry would be considered non-productive if the fracture system were absent. Although these fractures contribute so greatly to the effective permeability of the formation, less than 1.0 percent of the oil is calcu-

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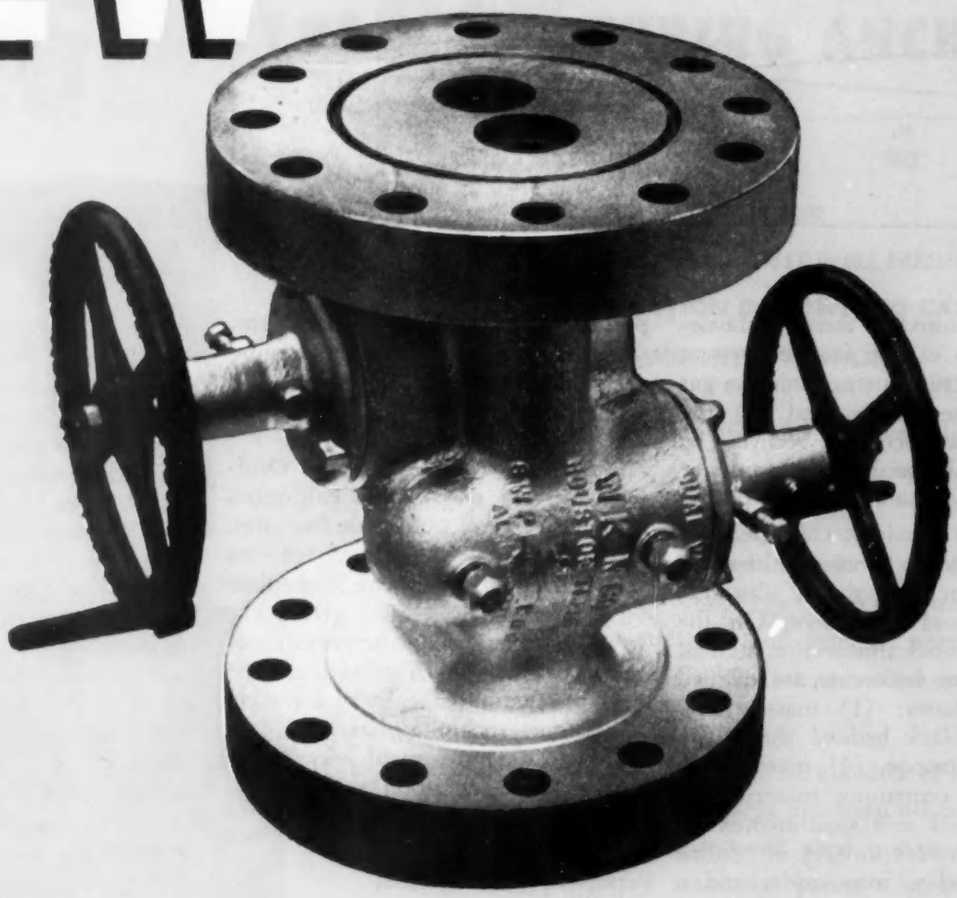

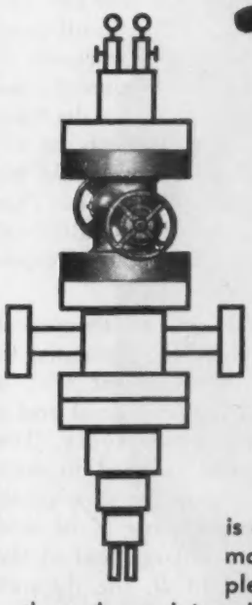

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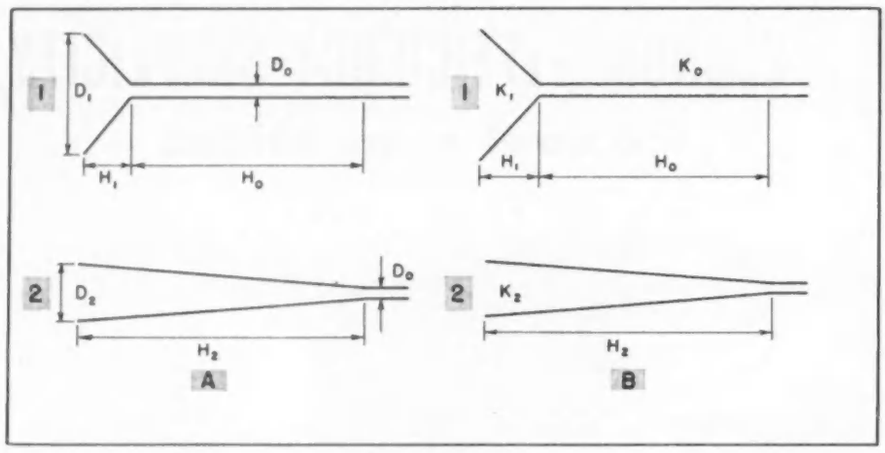

FIGURE 2

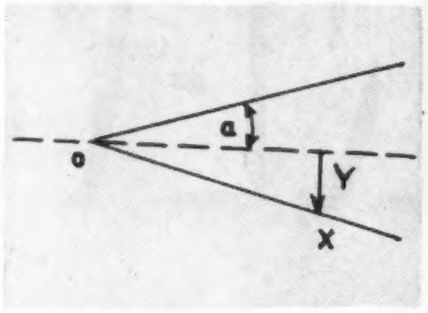

FIGURE 2 (a)

lated to be stored in them. Unfavorable features of the fracture system are: (1) fractures permit solution gas to bypass the matrix, and (2) the fractures make secondary recovery by water or gas hazardous because of probable fluid channelling.

The major lithologic characteristics of the Spraberry formation in order of abundance are shales, siltstones, limestones, and sandstones. On the basis of reported thin-section studies, the Spraberry sediments are divided into four classes: (1) massive silty shale, (2) black bedded shale, (3) laminated siltstone, (4) massive siltstone. The cementing material for these siltstones and sandstones reportedly consists mostly of opaline silica with clay, iron oxide, and a small amount of calcium carbonate.[5] Carbonates comprise from 1 to 3 percent of the total rock volume, and occur primarily as small, regularly scattered masses of calcium carbonate and dolomite.

The relationship between GOR, pressure, and oil recovery presented in Figure 1 show that GOR's had increased significantly above the solution ratio of 713 feet^3/barrels when only 3 or 4 percent of the oil in place had been recovered, and that a value of about 12,000 feet^3/barrels had been attained when less than 7 percent of the oil had been recovered. This performance is attributed to the low permeability of the matrix rock and the high degree of fracturing. With these characteristics, the retention of oil within the pores of the rock is significant. It is believed by some investigators[6] that end effects contribute largely to the rapid increase in the GOR and the subsequent rapid decline in oil productivity, while others[1] postulate that only gas will be produced when the reservoir pressure drops to about 1000 pounds per square inch.

Theoretical Considerations. Ordinarily, in a consolidated calcareous formation free of noticeable fractures, acid treatment will cause an increase in permeability in the immediate vicinity of the well bore, giving rise to a discontinuous and approximately radial permeability distribution.[7] The fluid-production capacity of a well in a reservoir rock that has been subjected to acid treatment may be expressed by the equation

$$Q = \frac{2\pi k_1 h\,(P_e - P_w)/u}{\log r_e/r_w + a \log r_e/r_o}, \qquad (1)$$

where:

- Q = reservoir fluid-production capacity in cc/sec.,
- k_1 = permeability to radius r_e in darcys,
- k_2 = original permeability of reservoir in darcys,
- h = thickness of pay zone in centimeters,
- P_e = reservoir pressure in atmospheres,
- P_w = bottom hole pressure in atmospheres,
- μ = viscosity of fluid in centipoises,
- r_o = radius of area effectively treated with acid in cm.,
- r_w = radius of well bore in centimeters,
- r_e = radius of effective drainage in cm.,
- $a = k_1/k_2$.

An increase in permeability of a few percent in a zone around the well bore only a few feet in diameter will greatly increase the productive capacity of the well.

The use of acid treatment is usually not recommended for sandstones with acid soluble contents less than 20 percent. Furthermore, since the acid soluble content of the Spraberry averages only 10 percent, acid treatment would not seem advisable, but because the existing fracture system provides an enormous area for the application of the acid to the matrix.

In the Spraberry end effects increase the saturation of the wetting phase (oil) which tends to reduce the effective permeability of the gas phase (non-wetting). According to Elkins[6] this decrease in effective permeability of the gas phase reduces the effectiveness of the gas for oil recovery because at a decreased gas flow rate the viscous drag on oil will be insufficient to overcome the capillary retention of oil. Theoretically, it is believed that acid treatment would tend to decrease the influence of end effects on recovery because acid action would increase the capillary diameters. This increase in diameter of any individual flow channel would reduce the capillary retention of the oil.

Figure 2A shows two theoretical capillary flow channels postulated to be the results of treatment with a commercial fast-acting acid and a slow-acting acid respectively. The commercial acid is assumed to react four times faster than the slow-acting acid. For a unit volume V of acid with an assumed enlargement of the capillary from d to D, the distance affected by the acid before becoming spent is H, which is the depth of a cone of unit volume V and diameter D. With the assumption that for the acid with the lower reaction rate the increase in diameter is only ¼ as much for a cone of equal volume, the extent of the effectiveness of the slow-acting acid will be over a much larger radius from the face of the well bore than would be obtained with an acid which becomes spent more rapidly.

Figure 2B shows the permeability distribution in the two capillaries

One piston tubing anchor keeps tubing in hole longer—cuts well pulling costs

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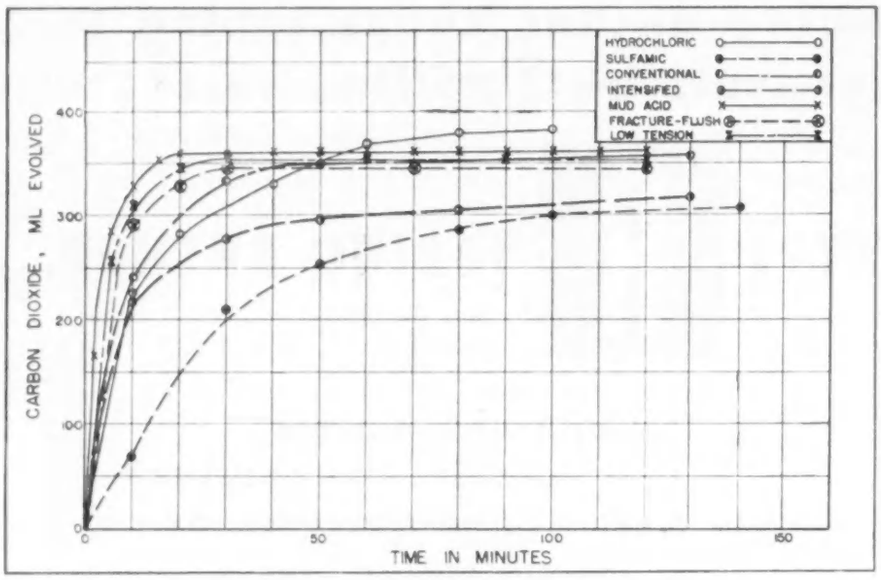

FIGURE 3

shown in Figure 2A. Darcy's equation for linear flow is

$$k = u\,Q/A\,(dp/dx) \qquad (2)$$

k = permeability,
u = viscosity of fluid flowing,
Q = average rate of fluid flow,
A = area over which flow occurs,
(dp/dx) = pressure gradient.

With a fixed area *A*, the change in rate of pressure drop p with respect to distance x is essentially constant. But if the area *A* is increased incrementally in the direction of flow x, this requires that (dp/dx) be decreased correspondingly if the permeability is considered constant. Referring to Figurge 2A, it is apparent that in capillary I no change in area of the flow channel occurs except relatively close to the well bore, while in capillary II a change in area occurs at a greater distance from the well bore. Assuming that the volume of each capillary enlargement is identical, there exists the relation,

$$V_1 \text{ (volume of capillary I)} = V_2 \text{ (volume of capillary II)} \qquad (3)$$

and

$$(1/3)\,(\pi r_1^2 h_1) = (1/3)\,(\pi r_2^2 h_2) \qquad (4)$$

From the point of the first enlargement of the capillary, the change in volume at any incremental distance dh along the axis of flow is expressed by

$$dV = (2\pi/3)\,(r\,dr\,dh) \qquad (5)$$

and hence, it follows from equation 3, that

$$(2\pi/3)\,(r_1\,dr_1\,dh_1) = (2\pi/3)\,(r_2\,dr_2\,dh_2) \qquad (6)$$

Since $A_1 = \pi r_1^2$ and $A_2 = \pi r_2^2$, it is seen that $dA_1 = 2\,r_1\,dr_1$ and $dA_2 = 2\,r_2\,dr_2$.

Substituting for r_1 in terms of r_2, and rearranging it follows that

$$dA_1/dA_2 = 16 \qquad (7)$$

From an examination of the relation of permeability in equation (2), for any change in *A*, (dp/dx) must vary inversely, hence, considering equation (7), if a 16 fold change in area occurs in the flow channel of a capillary over a given length, the pressure gradient (dp/dx) must vary inversely. It must be remembered that this effect is only over the length of capillary affected. But, from the volumetric consideration shown in equation (4), it is seen that $H_2 = 16\,H_1$.

Assuming the total pressure drop across the length of these two capillaries to be identical, it is obvious that the effective permeability k_1 will be larger than the effective permeability k_2. Also, k_2 will be much larger than k_0 which is the effective permeability of the portion of the capillary not affected by acid action. Thus it is seen that k_1 is larger than k_2, and that k_2 is larger than k_0; and since the capillaries are of the same length, $H_1 + H_0 = H_2$.

From Poiseuilles equation, the permeability "k" of a capillary tube is

$$k = \frac{r2}{8} \qquad (8)$$

where r is the radius of the capillary tube. The ratio of the total length, L_t, of the tube to the average permeability, $k_{av.}$, of the tube can be indicated by the equation

$$L_t/k_{av.} = L_1/k_1 + L_2/k_2 + L_3/k_3 + \qquad (9)$$

and substituting r2/8 for k,

$$L_t/k_{av.} = 8L_1/r_1 + 8L_2/r_2 + 8L_3/r_3 \qquad (10)$$

Or from Figure 2A,

$$\frac{Y}{X} = \tan a,$$

and

$$Y = X \tan a.$$

Therefore, by integration

$$L_t/k_{av.} = 8 \int dx/y^2$$

$$= (8/\tan^2 a) \int_{x_1}^{x_2} dx/x^2$$

Thus,

$$L_t/k_{av.} = (8/\tan^2 a)\,(1/x_1 - 1/x_2),$$

and the average permeability can be expressed as

$$k_{av.} = L \tan^2 a/8(1/x_1 - 1/x^2) \qquad (11)$$

By assigning values of $H_1 = 1$, and $H_2 = 16$ as determined above, and substituting in equation (11), it is found that $k_2 = 18\,k_1$.

Results

Reactivity of Acids: The rates of reaction of the various acids were determined by measuring the rate of carbon dioxide evolved from ground and screened (10 mesh) samples using an excess of acid.

The results of the reactivity determinations are shown in Figure 3. The commercial acids used were approximately 15 percent acid strength, i.e., equivalent to 6 N solutions. Sulfamic acid concentrations are limited to 2 N solutions because of the solubility of this acid in water. When using acids of comparable strength, conventional acid showed slightly greater capacity for dissolving the materials (mostly calcareous) present

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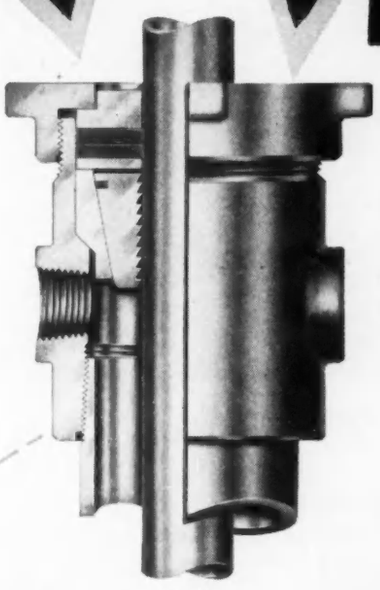

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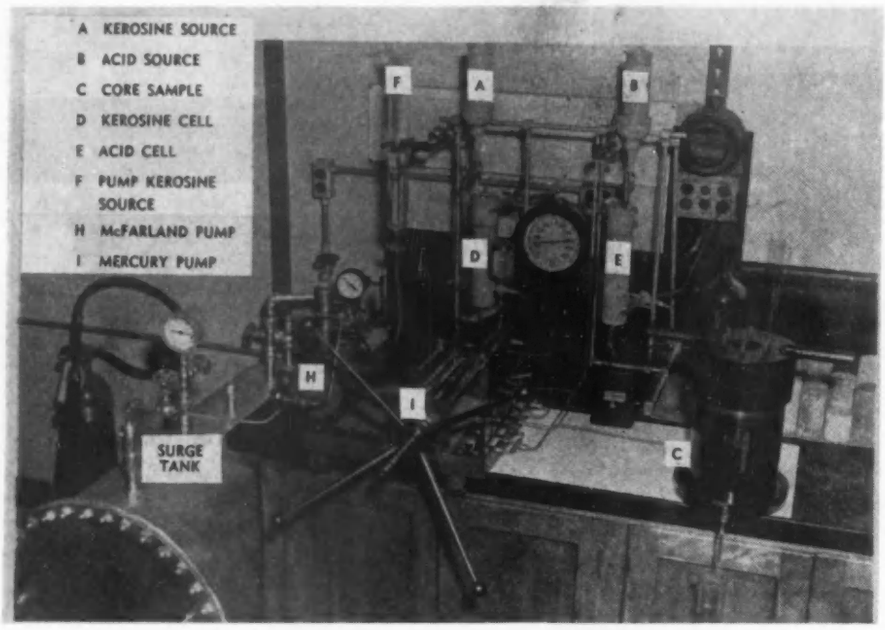

FIGURE 4—Acidizing Apparatus.

in the cores examined. The fracture flush acid showed the lowest dissolving capacity of the acids used. Sulfamic acid was found to have essentially the same dissolving capacity as hydrochloric acid, and would dissolve as much of the soluble material in a formation as hydrochloric acid, provided volumes of acids used for treatment were adjusted to allow for the difference in acid strengths.

As shown in Figure 3, with a sample containing 40 percent soluble material, the reaction of mud acid, low tension acid, and fracture-flush acid were practically complete within 20 minutes. Conventional acid and commercial 15 percent hydrochloric acid exhibited reaction rates showing complete decomposition of the carbonates in 50 minutes while intensified acid reacted to completion in 40 minutes. In comparison, the reaction with sulfamic acid was completed in 100 minutes. The treatment of a sample containing approximately 18 percent carbonates, yet having low permeability with the various acids showed rates 1.5 to 10 times faster than sulfamic acid.

Procedure

Permeability Determinations and Acidizing Procedures: Samples from cores of representative wells of the Spraberry formation used in reaction determinations were used for the permeability and acid treating studies. The cores were counterbored with a 0.5 inch diameter diamond bit, and then saturated with kerosine under vacuum for at least six hours. Cuttings from each core were retained for determination of the reaction rate, acid soluble content, and for porosity determinations.

Permeability determinations were made using the apparatus shown in Figure 4. To determine the permeability to kerosine, the kerosine cell was filled, and kerosine injection was begun by operating the McFarland pump at the slowest possible rate, appropriate valves being adjusted to allow measurement of the pressure.

Results of Acid Treatment: The results of acid treatments are summarized in Table 1. The maximum operating pressure that was used in a successful permeability determination was 1200 psi, while the maximum operating pressure used in acid treating was usually less than 900 psi. Field data on actual acid treatment show that the average breakdown pressure required for successful treatment is about 750 psi. The average acid injection rates for field treatments is about two barrels per minute, which indicates that field treatments are most likely accomplished with fracturing of the formation or injection of acid into existing fissures.

As indicated in Tables 1 and 2, sample R-1 was treated with 31 ml (1.4 pore volumes) of conventional acid and titration of the first 10 ml passed through the core showed the acid to be 25 percent spent, while the second 10 ml was found to be only 15 percent spent.

Core R-5 required 75 minutes for injection of 104 ml of sulfamic acid with a pressure differential of 750 psi. Although the original permeability and acid soluble content of this core were less than that of core R-1, the resulting increase in permeability was approximately three times greater than that obtained in sample R-1 with conventional acid. After 22 ml of spent acid had been returned, the acid was found to be 50 percent spent, indicating that even with a relatively high initial porosity (but low acid soluble content) the acid passes through the core without attaining complete reaction.

Core R-7 was treated with a total of 240 ml (4.4 pore volumes) of sulfamic acid with a resulting increase in permeability of 17.36 percent. This value represented the largest permeability increase obtained by any of the acid treatments. The acid was injected in three stages, each stage treat-

TABLE 1—Results of Acid Treatments

Sample	Acid Used	Soluble Content	Effective Porosity	Initial Permeability	Final Permeability	Change in Permeability
R-1	Conventional	11.063%	9.17%	0.417 md	0.425 md	1.92% increase
R-5	Sulfamic	7.36%	14.40%	0.028 md	0.030 md	7.14% increase
R-7	Sulfamic and Conventional	7.31%	15.20%	0.167 md	0.196 md	17.36% increase
S-18	Sulfamic	17.34%	10.86%	0.0047 md	0.0034 md	27.60% decrease

TABLE 2—Acid Treatments
Sample R-1

FIRST ACID TREATMENT
Acid Used: 25 ml. of Conventional Acid
Treating Pressure: 500-600 psi.

FLOW

Time in Minutes	Volume of Acid Injected, Milliliters	Flow Rate in Milliliters/Minute
0	0	....
67	24	0.359
84	30	0.352

Total measured acid return: 17 milliliters.

SECOND ACID TREATMENT
Acid Used: 25 ml. of Conventional Acid
Treating Pressure: 500-600 psi.

FLOW

Time in Minutes	Volume of Acid Injected, Milliliters	Flow Rate in Milliliters/Minute
0	0	....
52	18	0.349
80	27	0.348

ment consisting of 80 ml. Total injection time was 450 minutes with operating pressure differential of 750 psi. After 28 ml of spent acid from the first stage treatment had been returned, titration showed it to be 45 percent spent. Very large volumes of gas also were emitted from this core during treatment, and it was observed that a comparatively large volume of oil was recovered from the core after the first acid treatment. This indicated that the acid had created new channels to previously isolated pore spaces. The result of this particular acid treatment would seem to point to increased oil recovery from field treatments carried out in the same manner.

Core S-18 received five separate treatments, resulting in an over-all decrease in permeability of 27.60 percent. The extremely low original permeability (.004 md) was markedly reduced after the first acid treatment, but was increased gradually after the second, third, fourth, and fifth treatments. It required more than 28 hours to inject the 118 ml used in the treatment. It is evident that sections of the Spraberry similar to sample S-18 cannot be successfully treated with acid because the permeability is so low that the formation would be fractured if the high pressures necessary to obtain reasonable rates of injection were applied.

Vertical and horizontal thin-sections were made of cores before and after acid treatment. Photomicrographs were taken of the sections of matrix rock before treatment, at the well bore, and 0.4 inches, and 0.9 inches from the well bore after acid treatment.

Figure 5 shows a section of sample S-18 after treatment with sulfamic acid, and zones of varying horizontal permeability are indicated by the variations in extent of flow on the outer surface of the core. The paths or channels of acid action are further shown by vertical channels showing the existence of three vertical parallel microscopic fractures which had been acted upon by the acid.

Figures 6 and 7 are photomicrographs of thin sections showing calcite concentration before and after acid treatment. The sections of core R-1 (Figure 6) had been treated with conventional acid. The results of the acid treatment clearly indicate a sharp line of attack, all concentrated within narrow limits of the well bore. Figure 7 indicates the results of acid action on core R-7 which had an acid soluble content of only 7.3 percent and a permeability of 0.196 md. Effective acid penetration extended practically to the outer surface of the core, i.e., approximately 0.9 inches from the well bore. The fact that attack by the acid was evidenced by the absence of calcite throughout the length of core treated proved some superiority for this type acid even though the original permeability had been less than that of sample R-1 above, and the acid soluble content approximately 50 percent lower.

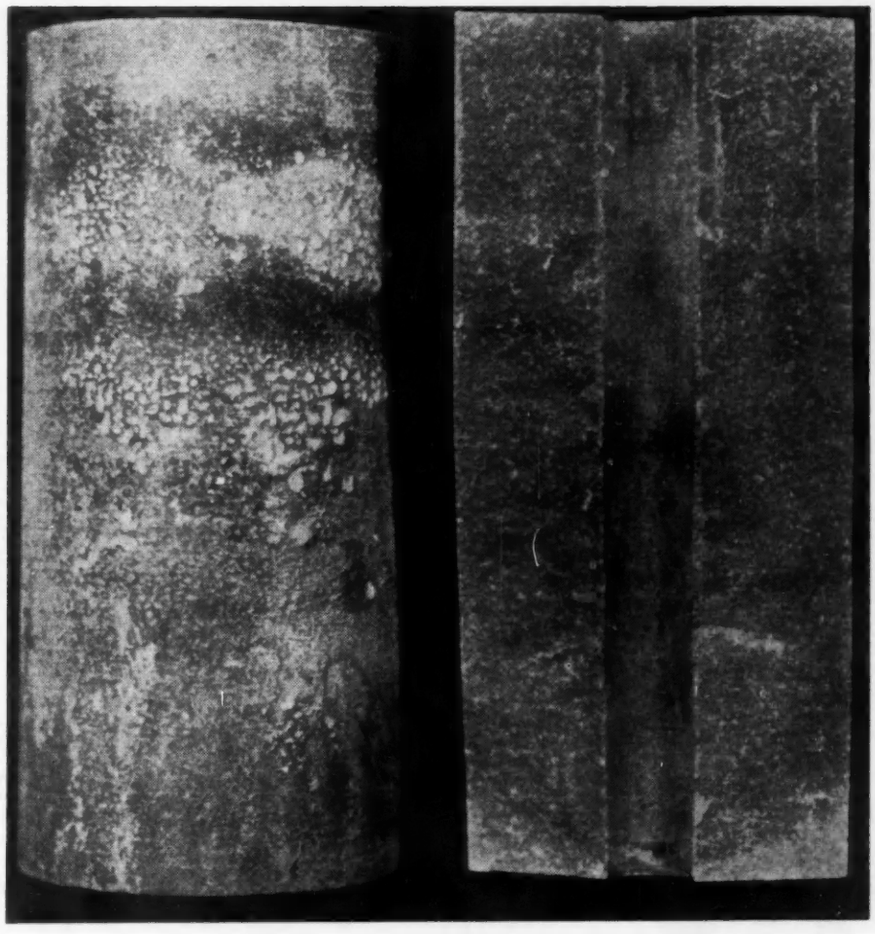

FIGURE 5

The cross-sections may not show the exact and total extent of the path of the acid through the pores of the core since obviously it would be impossible to secure representative thin sections of each portion of the core acted upon by the acid.

Petrographic analyses showed the presence of calcite, and contrary to a previous report Warn,[10] none of the cores examined indicated the presence of opaline silica. The petrology could vary greatly in a formation has the thickness and areal extent found in the Spraberry and hence the absence of the opaline silica may or may not be of significance.

Summary. The purpose of this investigation was to develop a feasible method of obtaining greater recovery from the Spraberry formation by increasing the porosity and permeability of the matrix rock.

The effects of acid treatments on the porosity and permeability were studied by treating core samples of the matrix rock with the several acids. Of the samples treated all showed permeability increases except one sample of extremely low permeability. Although the largest increase of this magnitude (17 percent) would be very beneficial to recovery efficiency if the zone of increased permeability extended a reasonable distance into the fracture blocks.

Petrographic analyses clearly revealed the effects of the acid action on the soluble carbonates in the matrix rock. The results also revealed that appreciably more acid action took place at a further distance from the well bore with sulfamic acid than

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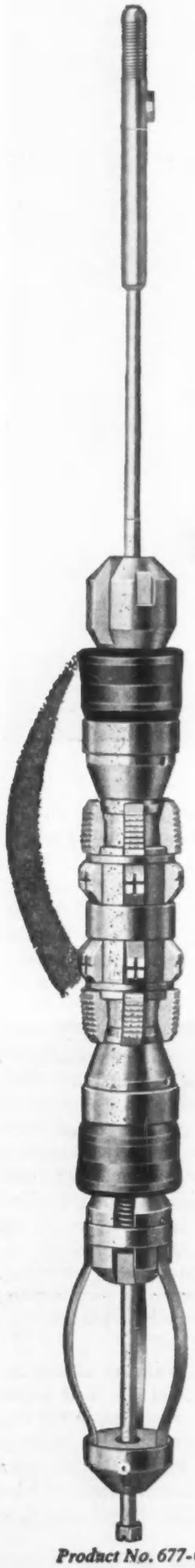

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The distance to be straddled is not limited by the made-up length of tool.

(b) *MULTIPLE Zone or Selective Testing, Fracturing, Acidizing*

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(b) Testing operations

(c) Temporary pressure containment to permit repair to or removal of well head equipment with safety.

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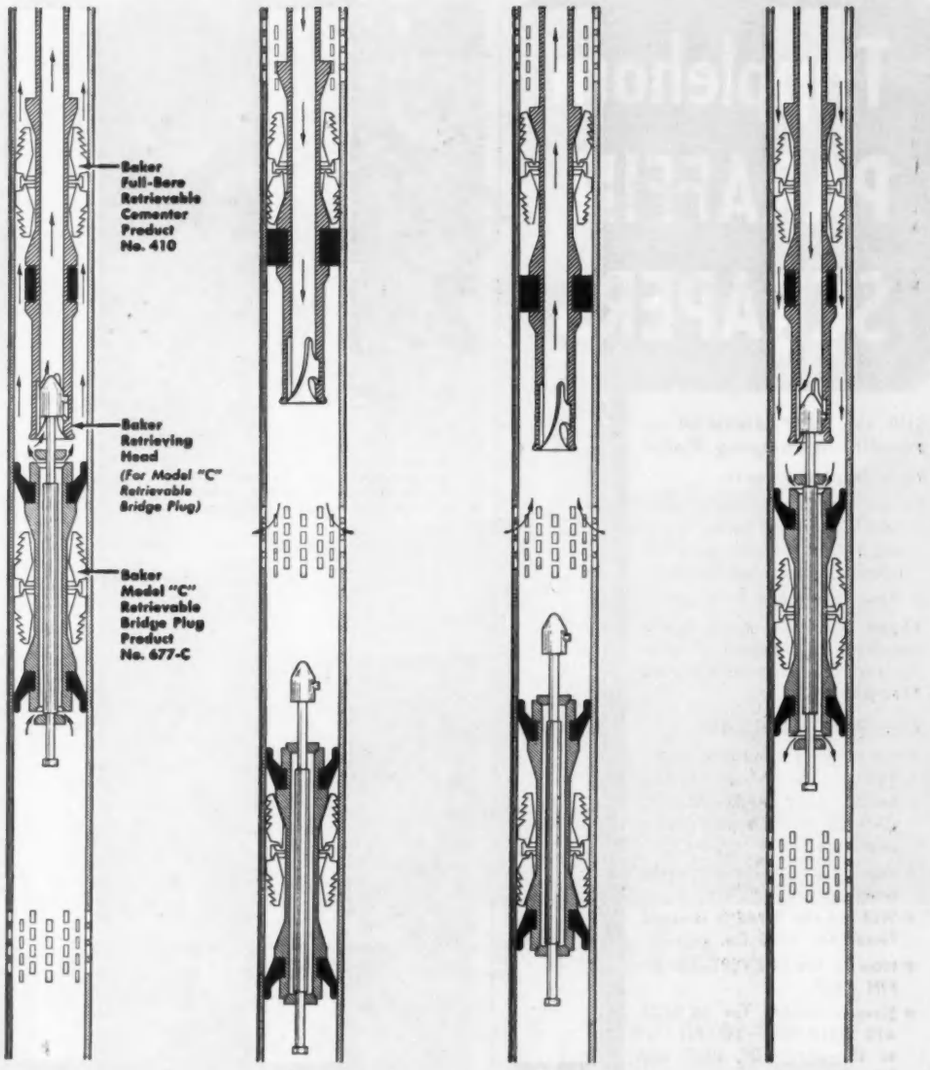
Baker Full-Bore Retrievable Cementer Product No. 410
Baker Retrieving Head (For Model "C" Retrievable Bridge Plug)
Baker Model "C" Retrievable Bridge Plug Product No. 677-C

RUNNING-IN
Retrievable Bridge Plug being run into well on bottom of Full-Bore Cementer through use of Retrieving Head. Note fluid by-pass.

FRACTURING OR ACIDIZING
Plug should be pressure tested after release. Cementer is released, raised above perforations and reset for pressure operations.

SWABBING, TESTING
Note how the reversal of pressure differential has transferred load from one set of slips to the other (both cementer and plug).

RETRIEVING
Plug and Cementer being moved to next set of perforations—or retrieved from well. Valves in plug open to permit fluid by-pass.

BAKER FULL-BORE RETRIEVABLE CEMENTER

HOLDS PRESSURE FROM EITHER ABOVE OR BELOW

Two sets of opposed slips enable the cementer to hold pressure from either above or below. Casing can be tested before squeeze—and the tubing also, if the Baker Full-Bore Tubing Tester is used.

FULL BORE CONSTRUCTION

Permits Passage of Tubing Perforators or Instruments—Assists in Preventing "Screen-Out" on Fracturing Jobs

The Full Bore through the Cementer (and Tester if used) is in reality a continuation of the bore through the tubing.

This continuous full ID passage not only permits passage of tubing perforators or instruments but assists in preventing "Screen-Out" (sand dropping out of the oil) and subsequent plugging of the tubing in fracturing jobs.

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The operation of the Cementer setting mechanism makes it easy (through the use of the Retrievable Bridge Plug Retrieving Head) to release and pick-up the Baker Retrievable Bridge Plug. It is in fact the ideal partner to the Retrievable Bridge Plug for selective multiple-zone or single-zone operations.

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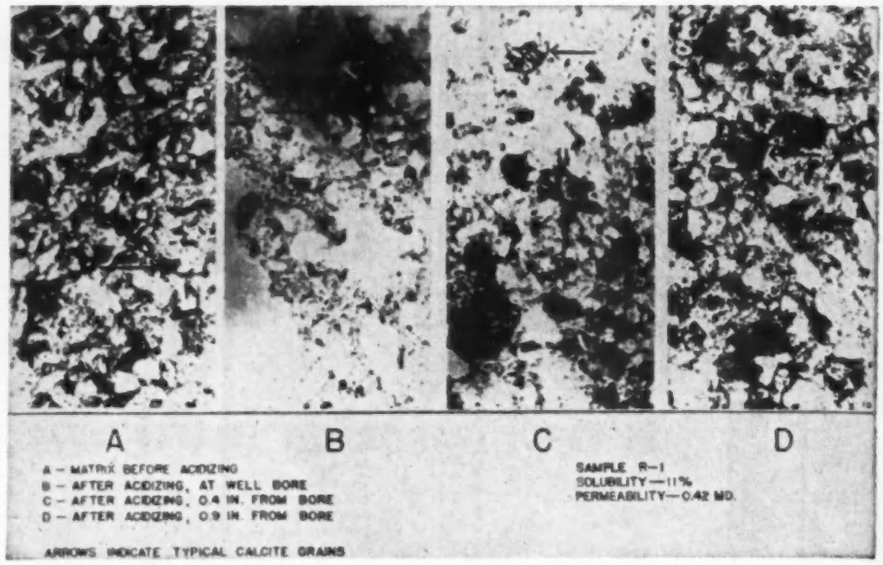

FIGURE 6—Photomicrographs of matrix.

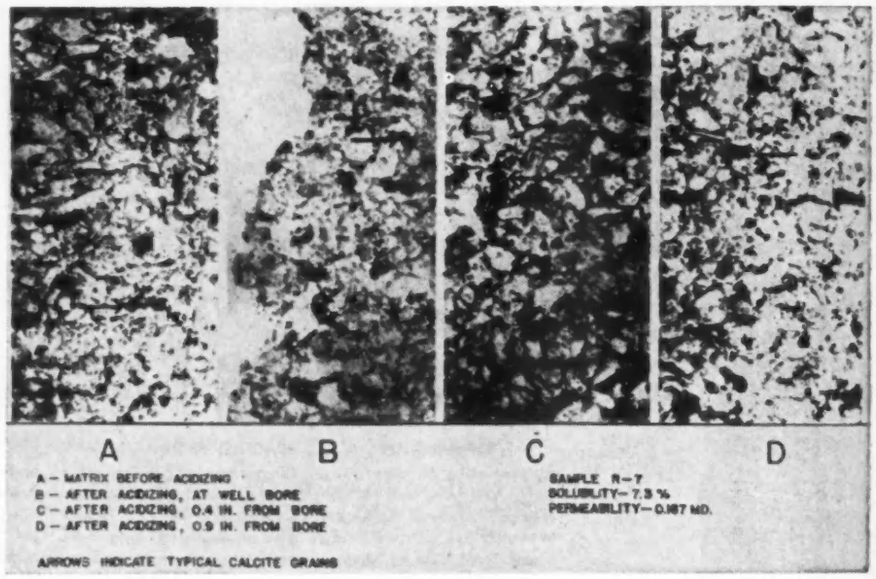

FIGURE 7—Photomicrographs of matrix.

with the commercial acids. Sulfamic acid produced larger permeability increases than was obtained with the commercial hydrochloric acids suggesting that sulfamic acid is a desirable acid for treating formations similar to the Spraberry. Possible field experiments or trials seem warranted.

Only through field testing of sulfamic acid as a treating agent can its effectiveness in increasing recovery of oil be determined. Certainly the problem of obtaining only a small fractional increase in oil recovery from the Spraberry Trend area fields justifies the trial use of this acid.

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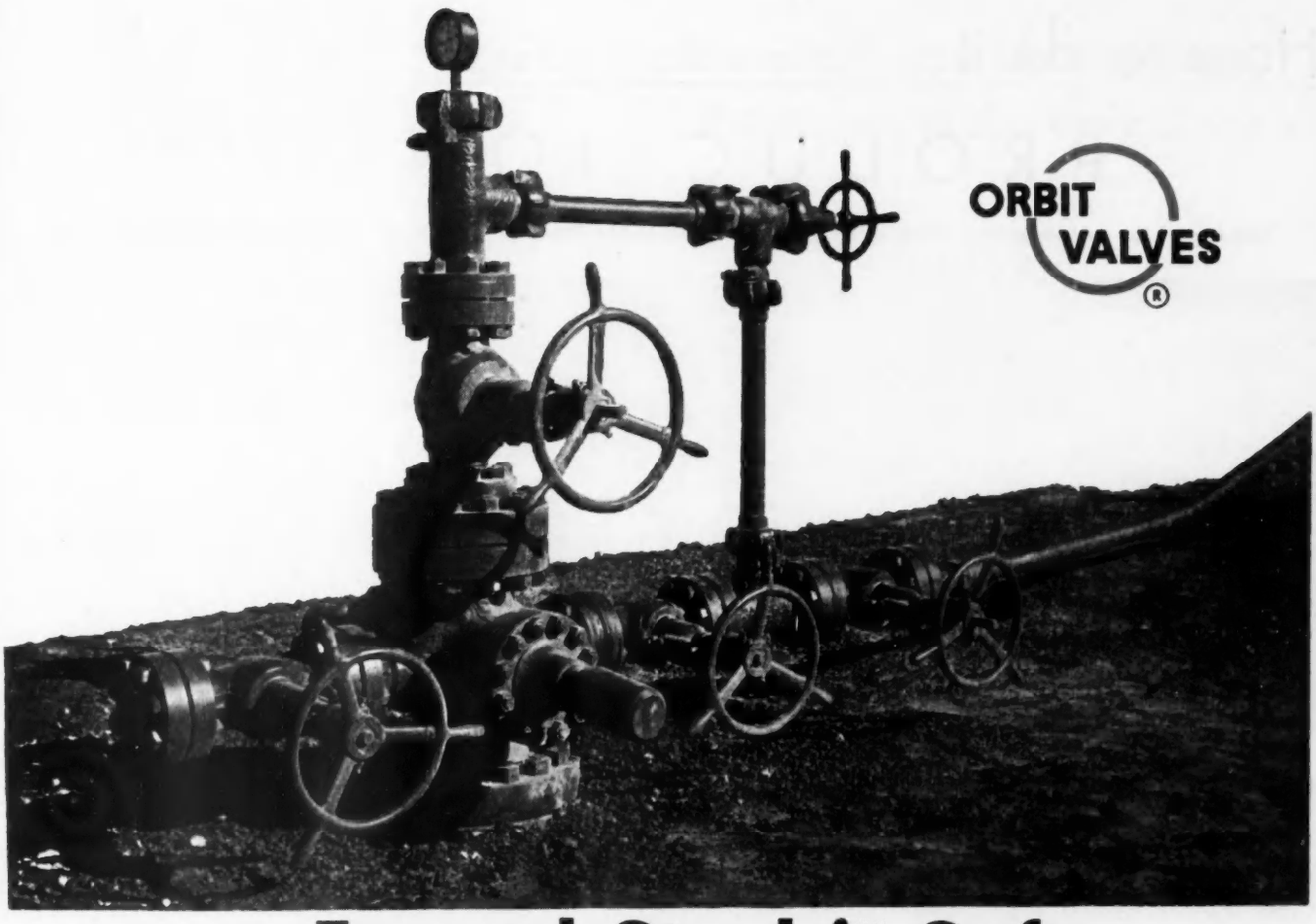
ACKNOWLEDGMENT

The authors wish to acknowledge the support given to this research by the Texas Petroleum Research Committee and to Dr. George H. Francher, director of the Petroleum Research Committee, for his aid and helpful suggestions.



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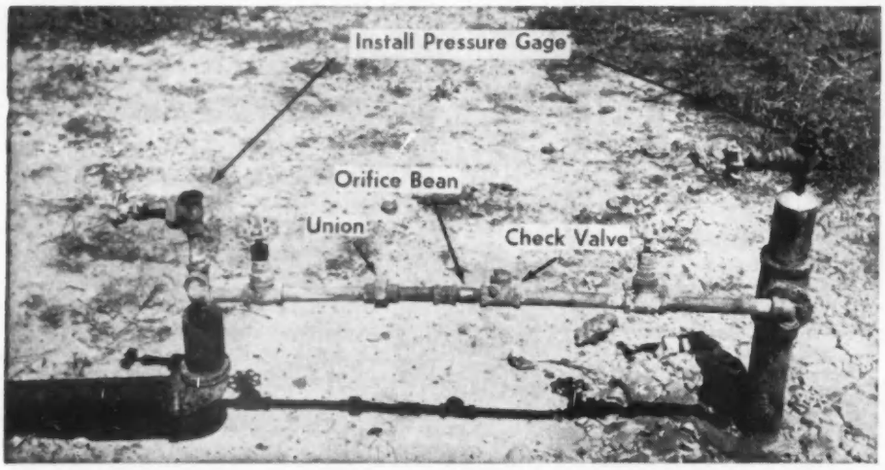
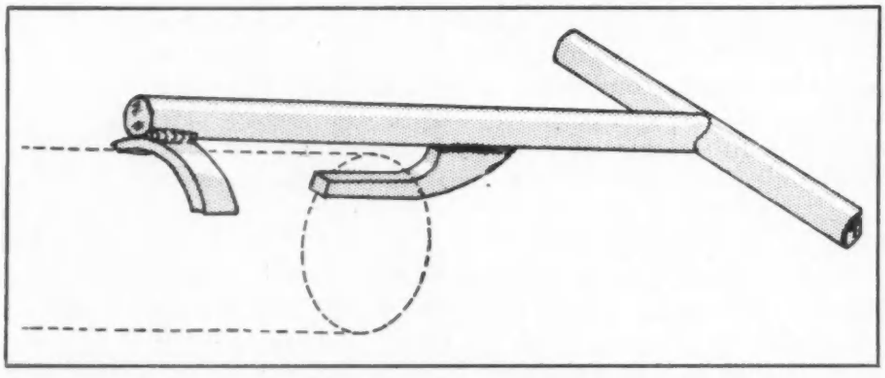


Orifice Bean Meters Water Input

One operator has standardized his water input well installations by equipping all wells with an orifice bean and half-inch gage valve for a unique method of metering input water. A 2 by ½-inch swage on top of the well head tee and another on the supply line riser afford easy access for quick installation of pressure gages.

Between the riser and the well head are two 1-inch valves, a 1-inch union, a check valve, and in the center, a precisely drilled stainless steel orifice bean. The beans are marked so that all that is required of the operator to determine the input rate to his wells is to install two pressure gages, read the line pressure, subtract the well head pressure and note the orifice size. Tables have been computed and are available to read water input rate directly from the chart.



Shop-Made Tool Prevents Smashed Fingers

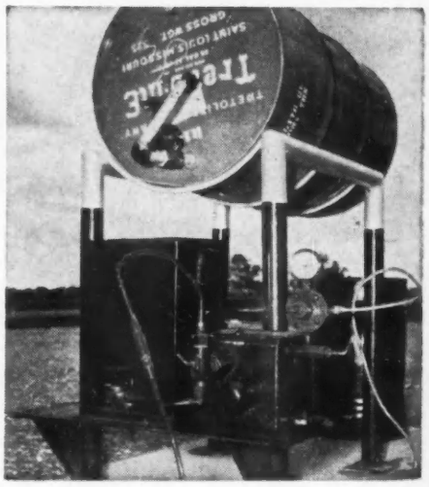
When handling pipe or tubing, especially in the larger sizes, it is sometimes difficult to obtain an adequate handhold. This is especially true when pipe has to be lifted on or off a rack or truck or carried a short distance. The pipe handling tool shown provides a safe handhold, preventing smashed fingers in case of a slip. Made from short lengths of scrap sucker rods and other scrap metals on the lease, it is light and can be carried in the tool box of the truck.

The hook that is inserted into the pipe or pipe collar is long enough so that it will be supported by the bore of the pipe and will not damage either the pin or box threads.

Build Inexpensive, Compact Chemical Injection System

The bothersome and time-consuming chore of daily chemical treatment of wells or tanks can be made easier by giving thought to particular requirements before purchasing and installing treating equipment. Daily dosages and injection conditions vary considerably so that each treating system must be designed to fit a particular situation.

One operator has built a very compact and inexpensive treating system out of scrap material. A rack is built of 2-inch pipe with the drum cradle made from sucker rod material. The rack is high enough so that chemical drums can be loaded on the rack from the tail end of a truck.



A shelf is welded to the two front legs and braced so that a gas-operated chemical feeder can be installed on the shelf and still be eight or ten inches below the bottom of the barrel.

A ¾-inch valve and suitable nipples are installed in the small openings of the barrel. The supply reservoir of the chemical pump is located directly below and the reservoir is filled each day with a predetermined amount of chemical from the supply drum. The chemical pump is gas operated and is supplied with produced lease gas.

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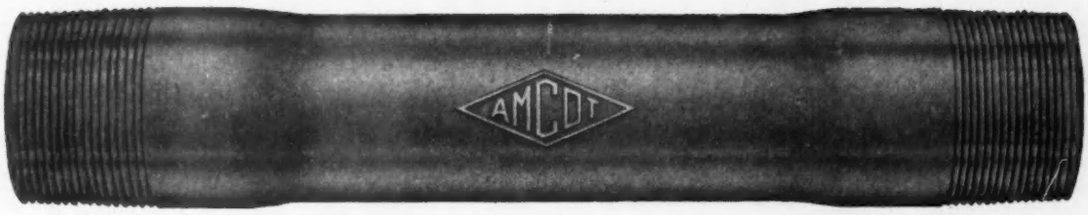

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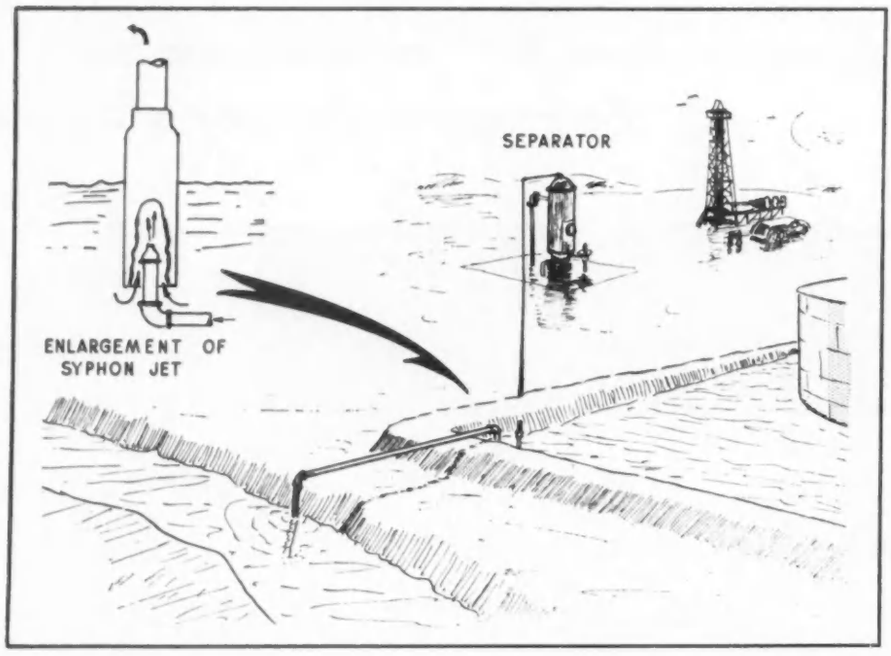


Jet Line from Separator Empties Dykes

When terrain features make it impractical to lay a gravity line away from the tank battery, a jet suction arrangement using power from the waste gas from the separator can be used. A tee is installed on the gas outlet of the separator ahead of the back pressure valve so that the separator pressure of 15 to 40 pounds is on the line when the gas is turned on.

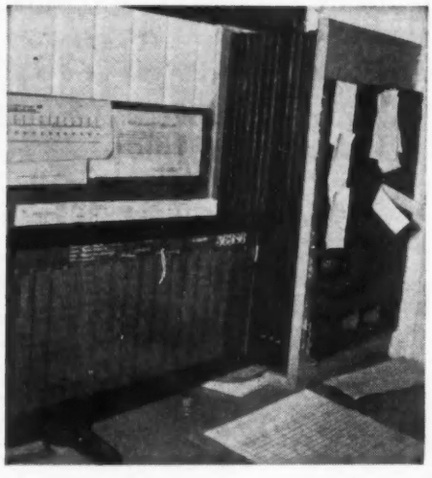
The jet line is made by taking a 2½ by 2-inch swage and installing a quarter-inch nipple in the bottom swaged down to ⅛-inch pointing up so that the stream of gas from the separator will be directed up the larger nipple. The 2½ by 2-inch swage is connected to suitable nipples and tees so as to run over the top of tank battery fire wall.

When the pumper comes on tour after a rain and finds water inside the tank dykes, he can turn on the gas and flush the water out in a few minutes. If the tanks should run over, there are no open drain lines to allow the oil to escape.

Rig Handy Rack for Lease Tank Tables

A pumper looking after more than one lease or a large lease with a number of tanks in the battery usually has quite a problem keeping all of the tank tables readable, but one pumper has developed a unique system for keeping tables neat, readable and readily available for daily figuring.

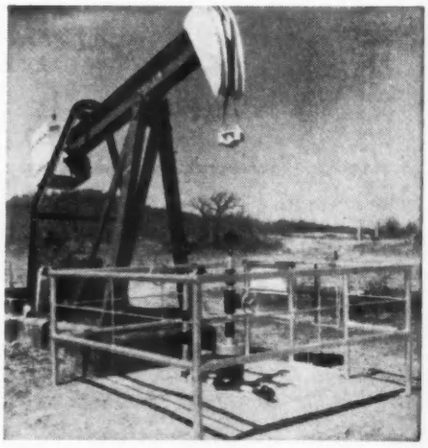
Each tank table is framed in the proper size frames, complete with glass front. A rack of the proper size to contain all framed tank tables is mounted on the top right hand side of the pumper's "knowledge box." The frames are hinged in place by bolting through the lower right hand corner of the frames. When not in use, the tables fold up into the rack out of the way as in the photo. When a table is needed it is swung down on the bolt hinge and drops across the pumper's desk in a handy position for working with the figures.



Mount Convenient Box For Tank Run Slips

When a lease storage tank is placed on the pipe line and the oil is run, run slips sometimes get lost, dirty, torn or stolen before they reach the proper person. Usually a receptacle of some kind is provided for these sheets or some arrangement is made so the foreman or pumper will know where to collect them.

One receptacle on a Gulf Coast operator's lease was made of thin sheet metal strips soldered together and was similar to a mail box, complete with hinged lid. This receptacle was fastened to the hand rail of the tank ladder and provided a handy place for the pipe line gager to leave his slip after taking the final tank gage.



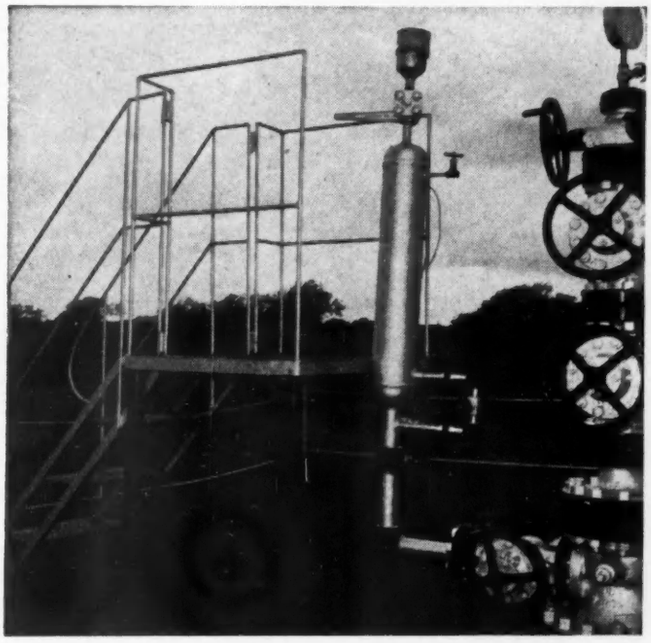
Flowing, Pumping Wells Protected by Guard

A prefabricated well guard which may be set over the christmas tree and still be used when the pumping unit is installed may be made from scrap material. Approximately ten feet by ten feet, the guard is made from 2-inch pipe with sucker rods used for the gate and lateral braces.

The frame is made solid by welding a piece across the bottom of the gate opening. The posts are set into holes in the ground or in buried sleeves. The entire assembly can be carried out on a winch truck and set down over the well head.

When the pumping unit is installed, the guard is reset with the railing between the christmas tree and the front of the sampson post resting on the front of the concrete foundation for the unit. This will provide a guard while the well is flowing as well as when it is placed on the pump.

Unitized Platform Facilitates Operation of Lubricator



A unitized platform provides easy access for servicing a chemical lubricator. The lubricator loading end is above a convenient working height because of christmas tree connections and size of the lubricator.

The platform is constructed of scrap material that is available on most leases. Legs of 2-inch pipe are cut to the right height for the particular well-head, and the bottoms are covered with 6-inch square pieces of steel for better support in the soft dirt. A piece of 1½-inch angle iron, welded to the top of the legs to form the base of the platform, is covered with steel non-skid grating.

The steps also are made of angle iron and grating and are constructed similar to the prefabricated tank ladders. Hand rails and guard rails are made of sucker rod material and are placed at a convenient height. The steps and hand rails are fastened to the platform by sleeves and hooks made from scrap metal and can be removed when necessary to move the platform.

Height of the christmas tree makes it necessary that some means be provided to reach the highest valves and fittings; the ladder and platform serve this need adequately. The platform also can be used for cleaning and painting the wellhead equipment and for easy installation of lubricators for bottom hole test tools.

Formjel is a temporary blocking or sealing material we use to aid the control of acid and fracturing treatments. It has been used successfully in thousands of wells to overcome permeability inequalities or weak planes in either limestone or sandstone, and also to direct the treating fluid into predetermined intervals

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Very probably, Formjel or its two companion agents—Firmjel or Thermojel—have an application in the treatment of your wells. If you are not fully acquainted with the many advantages we are able to offer you with these products, by all means ask your nearest Chemical Process Company station for full particulars, or write to us at Box 831 in Breckenridge, Tex.

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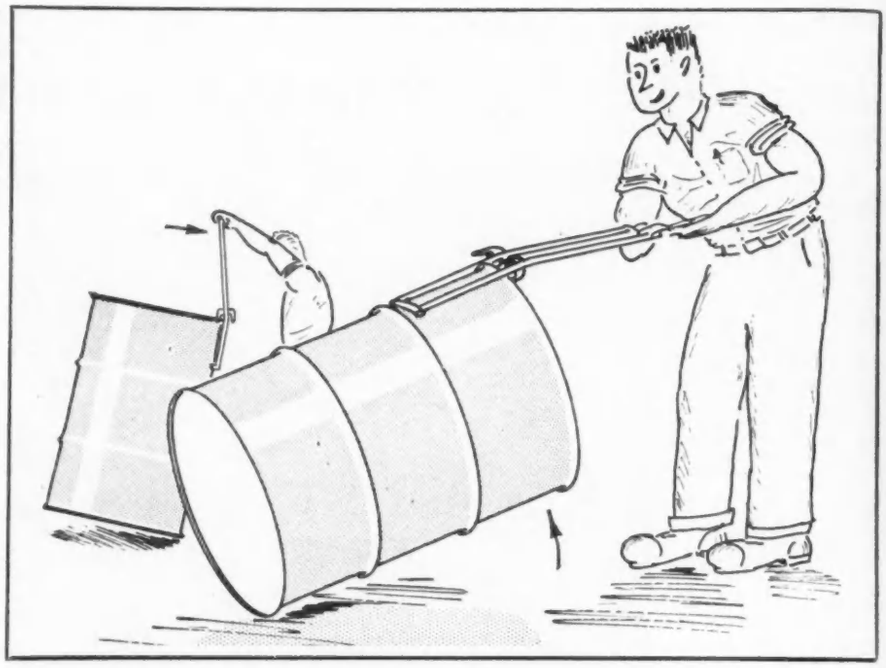
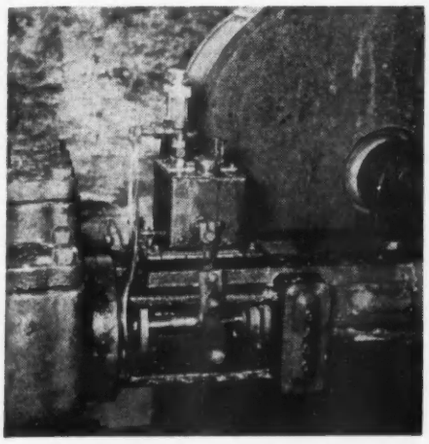


Make Barrel-Handling Tool from Scrap

A simple device can be constructed of scrap metal to aid in the handling of heavy drums. Made of ⅝-inch sucker rods, the device has two sets of lugs welded to the rods that catch under the lip of the barrel and enable one man to lower or lift heavy drums by providing an adequate handhold. The rods are bent slightly to facilitate lowering the drum or raising it to an upright position. The handle also is long enough so that two men, one on either side, can handle the drum if necessary.

Old Truck Tire Saves Lube Oil Drum

Unloading 300-pound drums from a truck often damages drums and sometimes results in loss of lube oils or other products. To prevent this, leave an old truck tire near the drum storage. When unloading, simply drive alongside the tire and drop the drums off on it. The tire takes the impact, and drums can be turned upright or rolled to the storage racks. The result—longer drum life and no loss of product.



Forced-Feed Lubricator Actuated by Piston Rod

Proper and adequate lubrication of the fluid piston rod and piston rod extension is important when pumping salt water. Improper lubrication or no lubrication at all will allow corrosive pitting of the rods with resulting damage to the plunger packing.

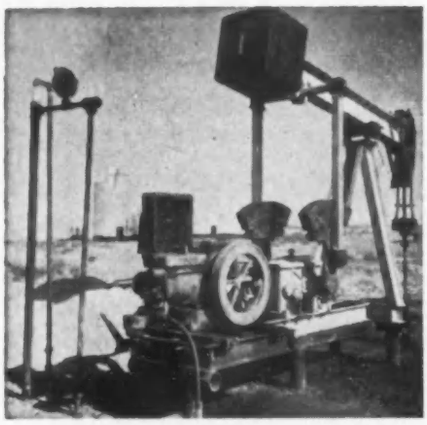
This problem is handled by one operator who has installed a forced feed lubricator directly over the piston rod at the front part of the power end housing. The lubricator is welded or bolted to the housing and, out of the way, does not interfere with the pump operation or maintenance.

The lubricator is of the rachet type and the actuating arm is bolted to one of the piston rods. Two ¼-inch copper tubes lead from the lubricator to the rods near the stuffing box and oil is pumped through these tubes on each stroke of the duplex pump.

This arrangement assures adequate lubrication of the piston rods and prolongs piston rod and rod packing life.

Install Risers to Dry Gas Operating Lease Engines

When gas is taken from the separators and heater-treaters to operate lease engines, it should be kept as dry as possible for best engine performance. A simple precaution is to place a riser on the gas line near the well so that the gas will rise several feet before going through the regulator into the fuel line. If other wells are using gas from the same line,



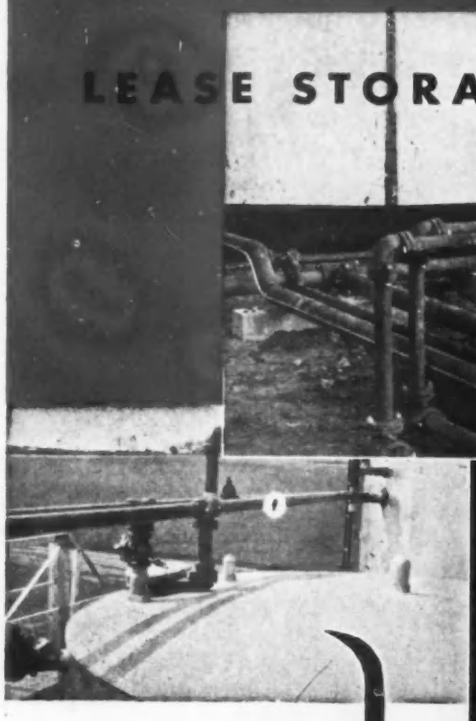
these lines also are connected at the top of the riser.

By placing the riser away from the heater-treater the gas has a chance to cool and condense out the heavier ends of the gas. A trap made from a joint of 6-inch pipe is placed at the bottom of the riser to provide storage for these condensates. Once the gas has had time to cool it is not necessary to have a riser at each well.

If any large gullies are crossed it is a good idea to install a tee looking-down in case it is necessary to install a drip at some future date.

WHEN CONNECTING

LEASE STORAGE TANKS



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Folding Cattle Guard Is Easily Moved, Set Up

A cattle guard that may be folded up for ease in transporting from one drilling site to another can be made by the welder. The road bed part is made in the usual way using 2-inch and 4-inch pipe. The 2-inch pipe in the middle is extended to form a brace for the fence post and a short 2½-inch nipple is welded on in a vertical position. The upright fence post support is made in triangular form with another 2½-inch sleeve welded into the apex of the triangle. This sleeve must be positioned so that the 2-inch fence post will pass down through it and enter the bottom sleeve welded to the brace. The cross piece at the bottom of the triangle has three sleeves on it that are welded to the 2-inch members of the guard grating. The bottom piece must be free to turn inside the sleeves.

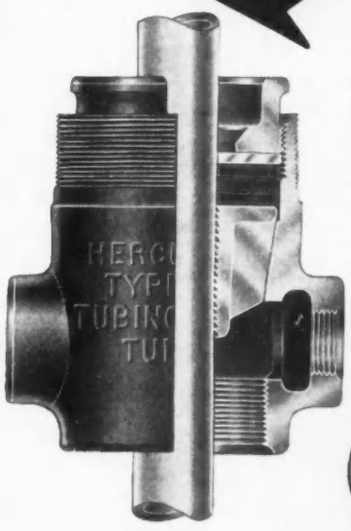
When disassembling, the fence wire is removed, the fence posts are lifted out of the sleeves, and the braces are folded in onto the guard grating.

Nitecap for Drilling Well Serves Several Purposes

On cable tool drilling-in operations that run only during daylight hours, the well stands idle 14 to 16 hours each night. Usually a bucket is placed over the hole to prevent objects from falling in the well. One operator, however, had a bull plug made for

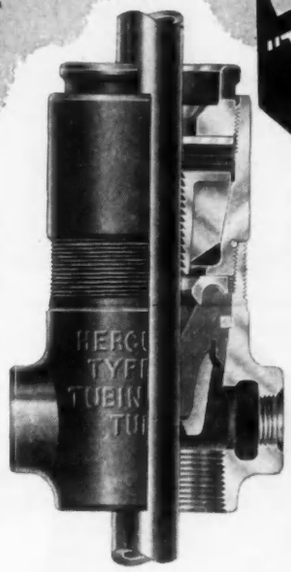
FOR RUGGED DEPENDABILITY

"Type J-5" TUBING HEAD for pumping or flowing wells



The maximum recommended suspension load is 180,000 pounds. Will suspend 2" tubing to 5½" casing. Head is full-opening; constructed of pressure cast steel tested to over 4,000 psi. Hercules original overhead packing arrangement and hinged slips facilitate installation and servicing.
Ideal for pumping or flowing wells; or for well servicing and repressuring projects. The Hercules Neoprene Tubing Stripper may be used in this Head on wells flowing intermittently, or to wipe tubing.

"Type J-5-S Stripper" TUBING HEAD for flowing wells



The dual-purpose "Type J-5-S" Stripper Tubing Head is basically a "Type J-5" Tubing Head with a bowl (top section) screwed into the packing nut thread. The hinged slips, packing and packing nut are installed in the bowl (top section) with the tubing stripper in the body (lower section), thus permitting tubing to be run-in, or removed under pressure. Test pressure is same as the "Type J-5" Tubing Head.

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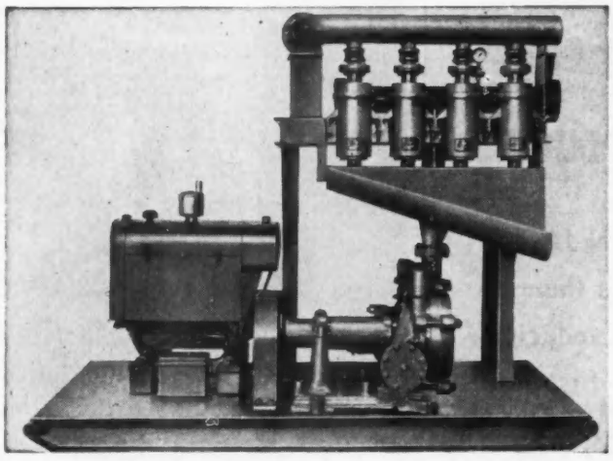

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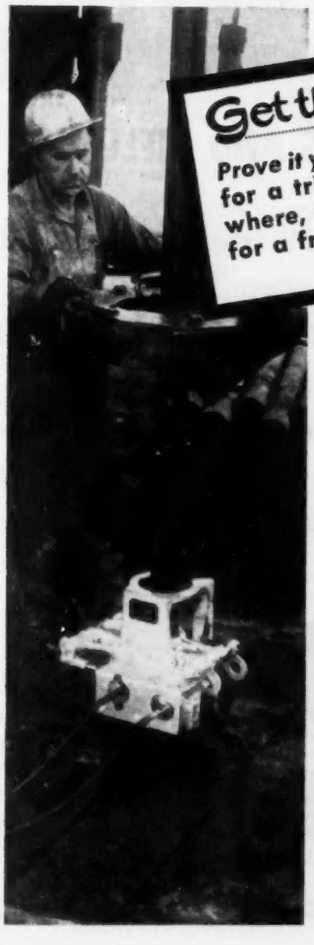

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the casing with handles and two small connections for valves so that any gas produced during the night could be detected.

Usually the nite-cap is screwed on using the handles and is bled down and removed in the morning. If there is considerable pressure on the well, a gage is put on and a calculation made to determine how much gas was produced into the casing.

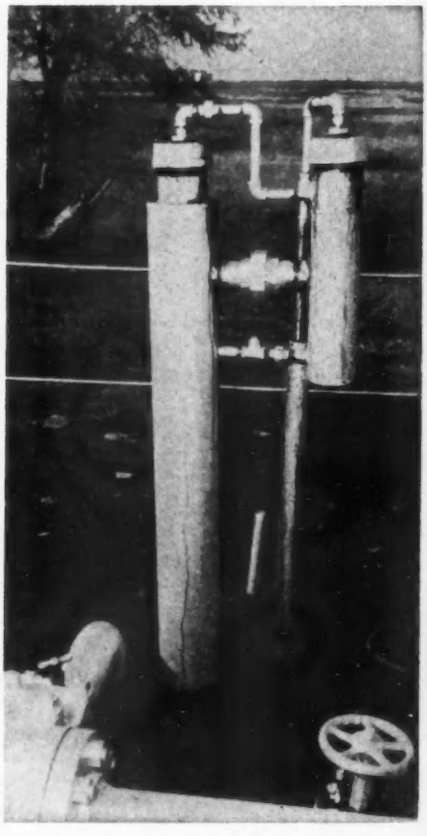
When the well is shut down, the bull plug is screwed on and a hose run from one of the valves to a bucket of water to see if the well is making

any gas. The object of this procedure is to note the very top of the pay and drill-in with least danger of drilling through the pay or drilling into water.

Shop-Made Float Chamber Prevents Gas Lock on Pump

A shop-made chamber fitted on the upstream side of a field pump will keep air from entering the pump and causing an air lock. The float chamber is connected to the side of a riser on the suction line with a union and a blind flange as shown. A check valve in the lower half-inch line allows the vessel to drain.

The upper line serves as a vent



line; as long as air or gas is in the riser it will pass out through the top of the float chamber. When the riser fills with liquid, the float inside the chamber rises and cuts off the flow so the pump will carry liquid. When another slug of air or gas enters the riser, the float valve will open and vent it.

The float chamber is connected to a sump to take care of any leakage through the float valve.

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Monopoly Well Raises Big Problems In Italy

- **Will Gulf's Alanno wells remain shut in?**
- **Will AGIP-Mineraria be permitted to produce its well?**
- **Will private enterprise be allowed to develop new field?**

THE INTEREST OF world oil circles is focusing even more sharply on the most recent turns of events in Italy, site of a sharply drawn line in the struggle between free enterprise and monopoly for developing the nation's petroleum resources.

The reason: Societa Mineraria Centro-Meridionale, a subsidiary of AGIP-Mineraria, which is controlled by Ente Nationale Idrocarburi, has completed a well at Vallecupa, in Alanno district, which tapped an oil structure at 1690 feet. ENI is a direct descendant of an organization set up as part of Mussolini's Fascist plans for a corporate state.

While production figures were not yet available on the Vallecupa discovery, indications were that the well was a smaller potential producer than the two wells, Cigno 1 and 2, which were drilled by Gulf Oil Corporation in the Alanno district. Both Cigno wells were brought in by Petrosud, which is owned 50-50 by Gulf Italia Company and Montecatini Mining & Chemical Company. From a depth of 2546 feet Cigno 1 flowed 35-gravity crude at a rate of 2830 barrels daily. That production rate exceeded ENI's total crude production in Italy.

At the time of the Gulf discovery, it was pointed out that geological conditions similar to the Alanno region exist down the eastern coast of Italy for, perhaps, 500 miles. Consequently, Italian geologists are comparing the 1690-foot level at which Vallecupa 1 reached the oil zone with the 2296-foot depth at Cigno 1 and 2680-foot depth at Cigno 2.

Thus, the monopoly discovery southwest of Alanno and the two private enterprise wells northeast of Alanno have presented the Italian government with domestic problems of major importance not only to the government itself but also to Italian petroleum interests.

Facing the government are these issues:

- Whether to maintain shut-in seals on Cigno 1 and 2, pending approval by Parliament of the projected new petroleum exploration and development law.
- And in the meantime, whether to authorize its monopoly to produce Vallecupa 1.
- Or whether, independently from approval of any new oil code, it should authorize private capital development of the field found by Gulf.

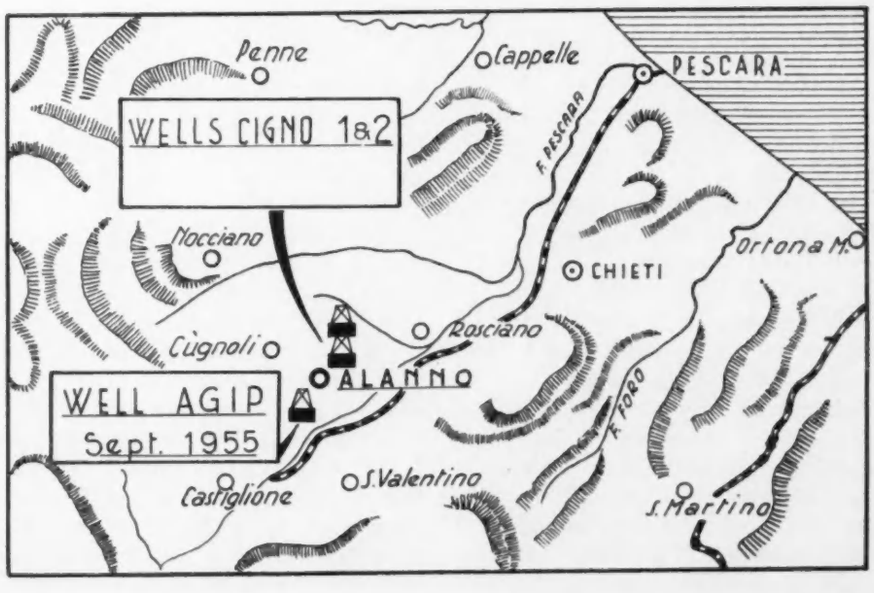
Remembered in Italian oil quarters, too, is the fact that the Italian state monopoly had tested the Alanno district in 1938 without success only to be followed by Gulf's more recent oil discovery.

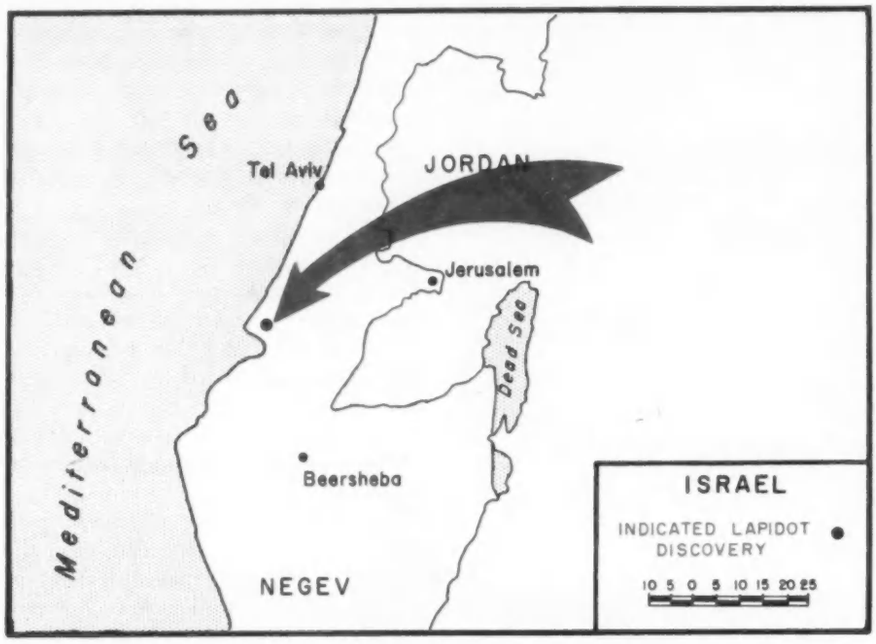
It is believed that all three wells are on the same structure. So the Italian government may find it necessary to revise the oil exploration permits issued to Petrosud so as to include permission to produce the wells and to develop the field.

Announcement of the Vallecupa well has sharpened the difference of opinion between supporters of the state monopoly and of private enterprise. It has been reported that Cavaliere del Lavoro Ernesto Fassio, head of a shipping group which owns about 12 tankers engaged in transportation of oil in behalf of the Esso and Shell groups, has been lending his support to the pro-monopoly segment.

Fassio's action has resulted in growing concern among Italian shipowners controlling tankers. They fear his move may cause U. S. and British oil companies which charter Italian ships to turn to other flags.

—The End





Israel's First Discovery Well To Undergo Extensive Tests

Lapidot Associates' Huleiqat wildcat, which found 30.5 crude at 4906 feet, brightens nation's economic and geologic outlook.

By HARRISON T. BRUNDAGE,
World Oil Staff

Israel's first oil production was discovered Sept. 22 when a wildcat drilled near the town of Heletz, 30 miles south of Tel Aviv and six miles east of the Egyptian Gaza coastal strip, struck oil while drilling at 4906 feet. When the drillstem was pulled, oil shot 65 feet into the air before the well was shut in. Gravity of the oil was reported to be 30.5. Extensive tests of the well are planned.

The Huleiqat test originally was spudded in 1947 by Petroleum Development (Palestine) Ltd, a subsidiary of Iraq Petroleum Company, drilled to a depth of 3464 feet, and plugged because of the Arab-Israel hostilities.

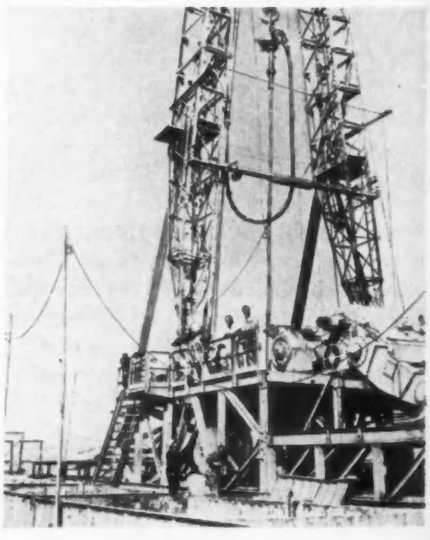
IPC's rights were voided, and after Israel's Petroleum Law was effected two years ago, Lapidot-Israel Petroleum Company, Ltd. of Tel Aviv (Israel and American interests) and Israel Oil Prospectors Corporation, Ltd. of Haifa (Israel, Swiss, and American interests), acquired a license to prospect for oil in the area. The company-owned rig used on the reported discovery previously was used on the Berri location, 15 miles to the south, where a 12,000-foot dry hole recently was completed. The old IPC hole was found to be in good condition after it was respudded in August, 1955, and the discovery took four weeks to drill. Originally, the test was projected to 9000 feet before oil was encountered. It is likely that the well will be completed in the 4900-foot zone without being drilled much deeper.

Rex Cheek, of Ball Associates, oil and gas consultants of Washington, D. C., commented that the 30.5-degree oil reported was essentially in the range that his firm would have anticipated for any oil found along this immediate trend. Ball Associates conducted an extensive geological survey of Israel in 1951 and 1952 on behalf of the Israel government and reported that the country generally has favorable possibilities for oil and gas production. The Ball firm also was instrumental in the effecting of the new Petroleum Law in Israel, following the completion of the geological survey.

The Ball Associates report "Oil Prospects of Israel" indicated that the Huleiqat test, plugged in 1948, drilled out of Pleistocene beds at 415 feet, and encountered earlier Cenezoic strata throughout most of the rest of the section penetrated, before it was completed at 3464 feet without encountering any Nubian sandstone. The 4900-foot pay zone apparently is of Cretaceous age.

Geologically, the indicated discovery will stimulate an already active trend along the Mediterranean shore. Farther to the west, Egyptian-American Oil Company, a subsidiary of Continental Oil Company, operating a big concession in western Egypt, is drilling below 7000 feet on a wildcat that may be drilled as deep as 15,000 feet. Non-commercial shows were found at 5100 feet. Still farther west, in Libya,

Continued on Page 245



This is the U. S.-manufactured rig used by Lapidot Associates to drill Israel's first oil well, about 30 miles south of Tel Aviv.

Two New Tests Scheduled in Papua

With current wildcat drilling below 5500 feet, Australasian Petroleum and Island Exploration continue to seek first commercial pay.

By **DON KLIEWER,** World Oil Staff

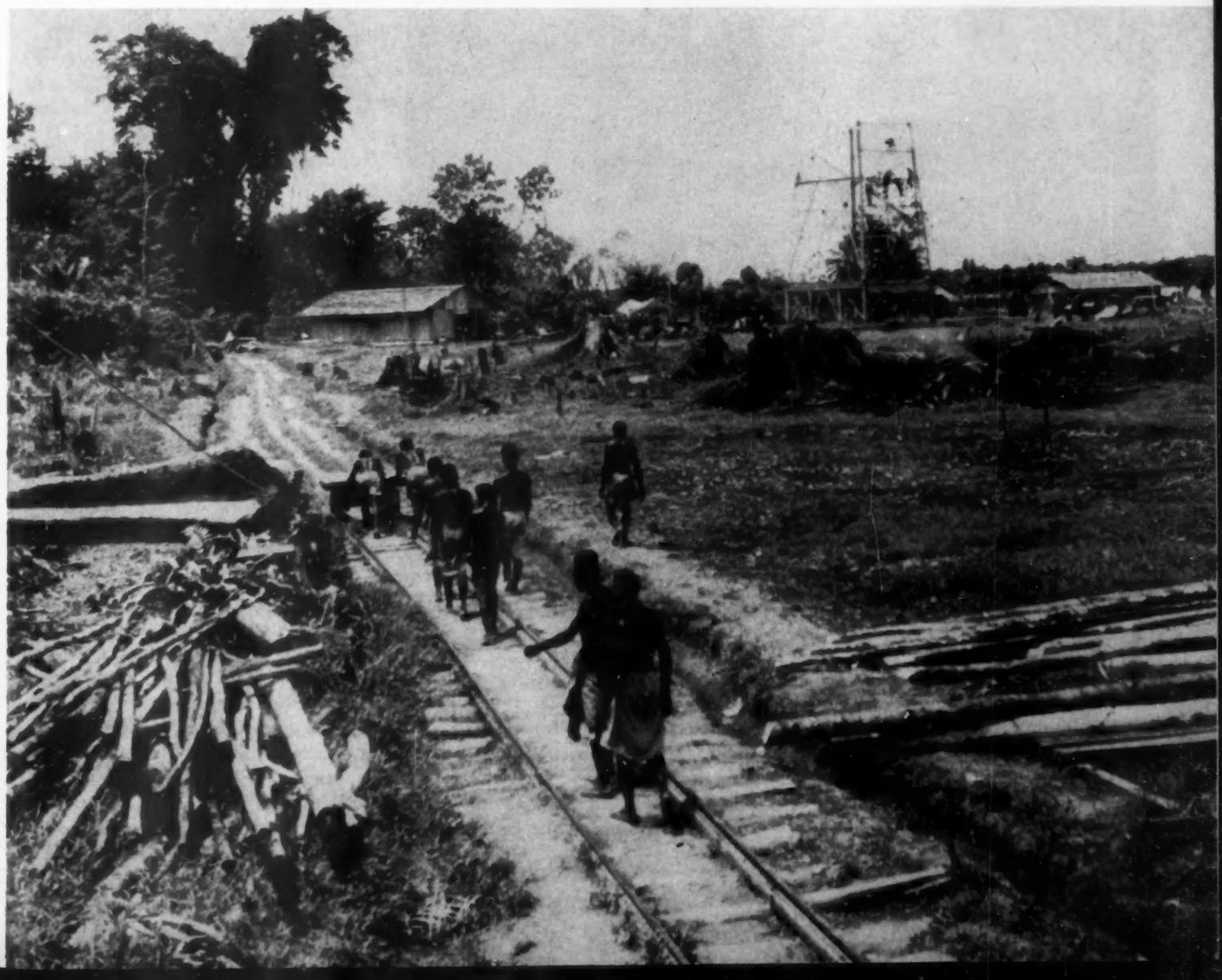
Australasian Petroleum Company and Island Exploration Company are preparing to drill two new test wells in Papua, located in the southeastern corner of the island of New Guinea. The only well currently being drilled by the companies, Aramia 1, was drilling ahead at 5500 feet.

The two companies, which since 1936 have drilled nine wells and total footage of almost 80,000 feet without commercial oil discovery, are owned by The British Petroleum Company, Standard Vacuum Oil Company and Australian interests.

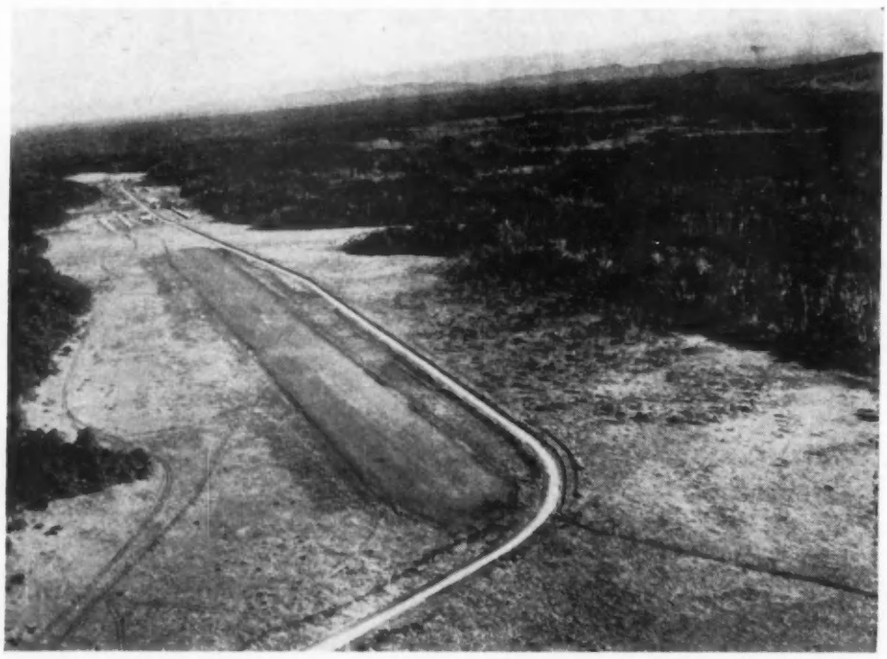
Extremely difficult operating conditions exist in Papua. One drilling site chosen—at Kuru—is seven miles from the nearest river, which provides the only natural means of transport. A road was built through the jungle so heavy drilling rig and equipment could be hauled from the river. Normally, this road-building would require but a few weeks, but because of Papua's torrential rain—up to 350 inches a year—and the jungle, the job was completed in 17 months.

To ship the heavy equipment up the rivers in Papua, three specially-designed landing craft were built in Britain. The first two—Geboso and

The drilling rig goes up in Papua as a narrow gage railway is laid through jungle clearing to move materials from warehouses to the derrick.



Flat-bottomed boats and native canoes are used to carry men and materials to and from survey camp sites in the dense Papuan jungle.



From an altitude of several hundred feet, the jungle terrain appears almost impenetrable. Shown here is one of the landing strips built in the vicinity of Australasian Petroleum Company and Island Exploration Company camps to provide quick transportation. Camp is situated in the upper left corner.

Gimada—left recently, towed by tug, on the 90-day voyage to Papua via the Red Sea and Indian Ocean. These craft will join the fleet of seagoing ships, river boats and native canoes operated by the oil companies.

In addition to several land-based aircraft, flying boats and helicopters are being used for transporting men and materials from bases to drilling sites and survey camps from which seismic, geological and gravity survey parties are mapping the county.

—The End

Second Jamaican Test Scheduled by Base Metals

Base Metals Mining Corporation Limited's second wildcat in Jamaica was scheduled to have been spudded in last month. This well, the result of continuing extensive exploratory program conducted in the Negril area, Westmoreland Parish, will be the first drilling effort on the island since Base Metals recently drilled Negril Spot 1, a dry hole.

However, the company reported that Negril Spot 1 proved the existence of oil on the island. It was then that exploration work was begun to select the most favorable site for Well 2.

Peron's Fall Clouds Oil Negotiations in Argentina

The rise of nationalist Major General Eduardo Lonardi to the post of provisional president of Argentina, following the fall of President Juan D. Peron, apparently will halt negotiations for exploration concessions in Argentina.

Lonardi said he would call off discussions with Compania California Argentina de Petroleo, a subsidiary of Standard Oil Company of California. This also involves the end of preliminary discussions with Standard Oil Company (New Jersey), and Royal Dutch Shell for similar concessions, it was reported.

Under Peron, the Argentine government had signed a contract whereby Standard of California's subsidiary could explore for oil under strict regulations. But despite the dictator's sponsorship of the action, opposition blossomed from both the Peronistas in the House of Deputies and Peron's opposition.

This contract was awaiting congressional ratification at the time of Peron's fall.

Argentina historically has contended with a major oil problem: the government monopoly produces significantly less than the domestic demand level. The unratified agreement with Standard of California covering a section of Patagonia called for the company to sell all the oil it discovered to the government, unless a surplus developed, and for the government to share 50-50 in any profits.

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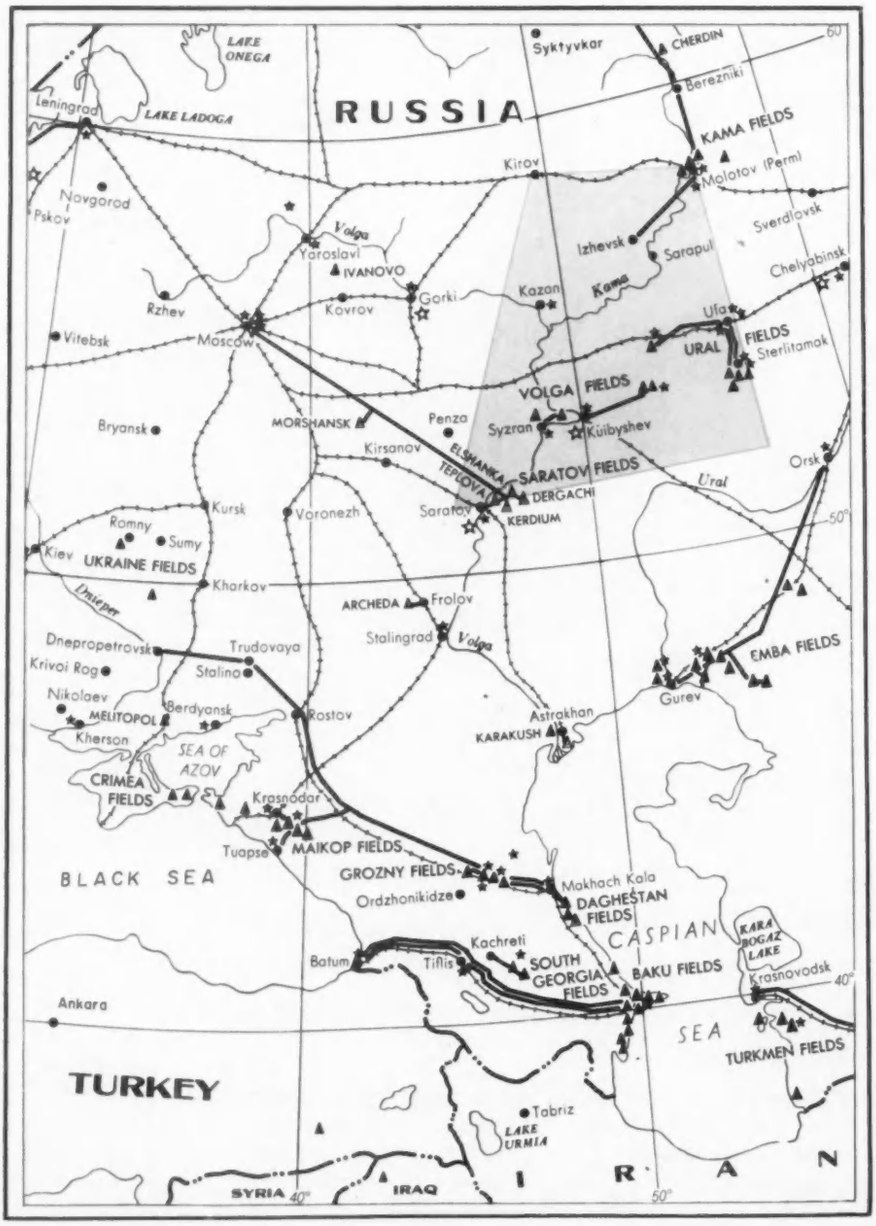
ANOTHER WORLD OIL REPORT FROM BEHIND THE IRON CURTAIN INDICATES:

- Bashkiria's crude yield rising.
- Geological and other exploratory efforts are bringing results.
- BUT—evidence points to widespread inefficiency in all phases of oil industry.



RUSSIA'S SECOND BAKU, the vast, promising oil producing area between the Volga river and Ural mountains, has become the focal point of the USSR's expanding petroleum industry.

This relatively new oil region, covering an area three times as large as Italy, is receiving more and more attention in the Soviet press as the spotlight of publicity shifts away from Old Baku fields in Azerbaijan.

Part of the interest in and enthusiasm for Second Baku is sentimental, stemming from the Kremlin's consideration of the region's development during the past 25 years as a great communist achievement. Azerbaijan fields, on the other hand, resulted from private capital, although the Russians claim that more than nine-tenths of the oil produced there today comes from strata discovered by Soviet geologists.

But Second Baku—centering in the Bashkir and Tatar Autonomous Republics—also has solid claims to top-rank importance. Soviet authorities have become increasingly positive in their statements that known oil deposits in the area equal or exceed those in Azerbaijan.

Equally important are Russian reports which admit frankly that Azerbaijan's coastal and inland field production has shown no significant increase during the past three years and that recent exploratory drilling on land has been unsuccessful. Capi-

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tal expenditures per barrel of oil produced from new Azerbaijan wells were more than three times as high in 1953 as in 1946.

Only the expensive development of offshore deposits beneath the Caspian sea (WORLD OIL, August 15, 1955, Page 139) appears able to keep Old Baku, whose production dates back to 1869, from a slow decline and from gradually yielding its title of Soviet oil capital to the territory farther north and east.

Second Baku holds an important geographical advantage over other major Russian oil-producing regions: unlike the Caucasus, Trans-Caspian and Sakhalin areas, it is fairly well located for consuming centers. The communist party newspaper Pravda recently estimated that Bashkiria oil costs the government "several times less" than oil produced elsewhere in the country.

Pravda continued:

"Development of Bashkiria's oil deposits by the most progressive methods has resulted in high economic indexes, labor productivity has increased almost 40 percent in the past four years, cost of producing a barrel of oil has declined to 66.9 percent of the 1950 figure, and major gains have been made in oil refining.

"Wells are now being drilled by the progressive turbine method. Electric drills are beginning to be used. A method of using water instead of a clay solution in drilling wells has been developed and introduced.

"By using better equipment and new methods, many crews are now drilling wells 1700 to 1800 meters (5575 to 5900 feet) deep in 19 to 20 days, as compared to three or four months not long ago. Drilling of operational wells now costs a third as much as previously.

"The length of well development in the Tuimaza fields of Bashkiria has increased several times, and output has increased considerably through artificial maintenance of pressure with water injection. Tuimaza well No. 100, drilled to the Devonian horizon, has been flowing for ten years now, yielding more than 500,000 tons (3,633,000 barrels) of oil in that period. The well's present output is about 110 tons (800 barrels) daily."

(The pioneer Tuimaza 100 was completed in September, 1944, at a depth of more than 6000 feet. It took nine months to drill this first Devonian well in Tuimaza fields.

(Last year, with "socialist competition" in full swing, one top crew in the adjacent Tatar Republic reportedly drilled 10,028 feet in a month—more than six times the average rate. This was a record for the hard rocky strata characteristic of Second Baku. In Azerbaijan, crews reportedly have drilled as much as 14,715 feet a month by the turbine method.)

Soviet press reports that Bashkiria successfully completed its assigned quotas for oil drilling, production and refining in 1951, 1952, 1953, and 1954—the first four years of the current Five-Year Plan. Production in 1953 of more than double the 1950 level was claimed.

Crude production reportedly rose another 20 percent in 1954, "with output approaching that of Azerbaijan." Bashkiria hopes to become the USSR's top oil producing area in 1955.

In contrast to Azerbaijan, survey and exploration work in Bashkiria is said to be meeting with good results. Pravda claims that important deposits for long-range development have been found.

"In one recently discovered area, test wells drilled to the Devonian horizon have disclosed large amounts of oil. It is estimated that in terms of supply the deposit is equal to the Tuimaza fields," said Pravda.

Despite prevailing Soviet optimism regarding Bashkiria's oil resources, there still is evidence of widespread inefficiency in exploration, drilling, production, refining, and transportation.

Key installations necessary to develop new areas frequently are built at a snail's pace. Red tape and wasteful use of funds and materials have marked the construction of oil, natural gas and water pipe lines, pumping and compressor stations, storage facilities, power plants, and roads.

Pravda contends that the slow rate of industrial development of new deposits is due in part to poor use of drilling equipment.

According to Pravda:

"Experience of leading workers shows that a crew can drill 10,000 to 12,000 meters (33,000 to 40,000 feet) a year and put 6 to 8 wells into operation. However few crews in the Bashkir Oil Federation maintain this rate. Most crews drill only 4000 to 5000 meters (13,000 to 16,500 feet) a year.

"This is because some managerial personnel are content with earlier achievements and no longer notice shortcomings. Can it be considered normal when a drilling crew is without work for weeks because operations have not been correctly planned or prepared?

"In the Tuimaza Oil Drilling Trust, for example, the leading crew recently drilled Well 1167 in 20 days and then remained without work for 19 days. In 1954 alone enough time was lost throughout the Bashkir Oil Federation to drill at least 50 wells more.

"The best construction techniques have not been used on Bashkiria's new wells. Drilling methods have improved measurably and the mechanical speed of drilling has increased, but the manner of building derricks and installing equipment has not changed.

"In the neighboring Tatar Autonomous Republic, oil workers have greatly speeded up derrick construction and reduced down time of drilling crews. But directors of the Bashkir Oil Federation evidently consider it dishonorable to copy and actively introduce this valuable experience.

"Such arrogance and conceit are intolerable. They are alien to the spirit of Soviet managerial personnel and to the idea of socialist competition. We must use the advanced experience accumulated in other regions of the country in the Bashkiria oil fields.

"Our opportunities for exploratory work also are far from being used fully, although some good results have been achieved. Because of a lag in structure-survey drilling, we are exploring new areas with deep-drilling machines. This involves extra work and expense.

"Construction of drilling bases plays a major role in successful exploration. But this work is being carried out poorly in Baskiria. The Ministry of the Oil Industry, which is not lending proper assistance in this matter, is largely to blame."

Downtime of drilling rigs is espe-

Continued on Page 245

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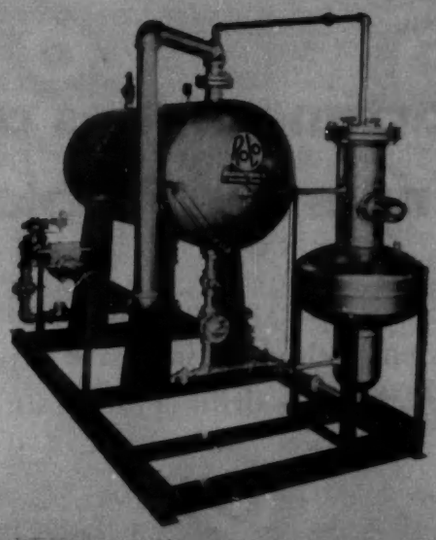

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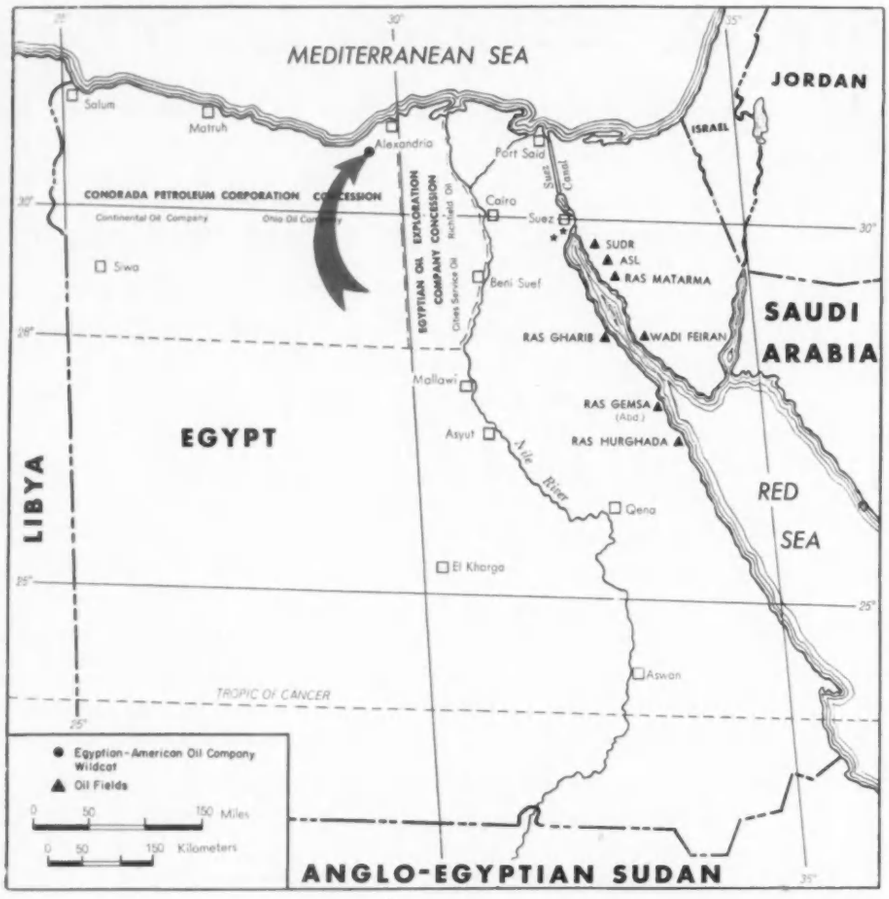

Wartime Mines a Costly and Dangerous Problem in Egypt

Egyptian-American is educating Bedouins in detection methods as intensive exploration continues. Test near Alexandria drilling ahead at 7000 feet.

At the Egyptian-American Oil Company's special school at Burg el Arab, 40 miles west of Alexandria, Egypt, six ex-U.S. Army mine warfare experts are training Bedouin tribesmen to use mine detectors. Danger of death and destruction from World War II land mines is a real problem facing personnel and operating units of Egyptian-American.

The company, subsidiary of Continental Oil Company, is the operator of two concessions totaling about 90,000 square miles for four interested U.S. companies, and will spend more than $2.5 million in 1955 and 1956 clearing and marking safe roads through the mine fields. It will not be possible for the company to clear all the mines, since they cover virtually the entire coastal area from historic El Alemain 250 miles westward to the Libyan border. In addition, much of the area farther inland in the western part of the concession area is mined also.

Almost all of the mines are of the metallic anti-tank variety. The Allied and Axis forces did not have plastic anti-personnel mines in use at the time of most of the fighting in Egypt. Tanks and other heavy vehicles were the primary target of mining operations. Military records indicate that 30 million mines were laid in the western desert between 1939 and 1942. It is estimated that a third of them are still there.

Exploration is proceeding rapidly. Egyptian-American has a firm commitment to spend at least a million dollars annually in the Conorada (western) concession during the first three years, and $300,000 annually in the eastern (Cities Service) concession. Actually expenditures have reached an annual rate of $8.5 million. Most of the land area involved has been photographed from the air The western concession includes Egypt's territorial waters directly north of it, and some preliminary offshore work has been done.

Gravity survey has progressed rapidly through the use of helicopters, without which gravity work in the mined area would be much slower. Three seismic crews and at least five surface geological parties were operating in June, and Egyptian-American hopes to have eight surface crews and two rotary rigs in operation by the end of 1955.

The company spudded its first well at a location 28 miles southwest of Alexandria (see map), near the coast, early in June. Initial progress was slow, owing to the presence of very soft sand to a depth of at least 100 feet, to which depth 23-inch conductor pipe was driven. During the first three weeks, 1500 feet of hole was made under similarly difficult conditions. The well was drilling ahead at 7000 feet, after the only oil show was found at 5100 feet. The operators are prepared to carry the well as deep as 15,000 feet if commercial production or basement are not encountered at a lesser depth and circumstances warrant so deep a hole. The well is being drilled on a seismic structure of considerable magnitude. The Cretaceous and Jurassic formations, so prolific in the Persian Gulf area, are the main target, but the Tertiary beds, productive in the Gulf of Suez graben, are prospective also. It is not possible at this time to predict the depth of the tops of the Cretaceous, Jurassic, or basement.

Previously, Standard Oil Company of Egypt, an affiliate of Standard Oil Company (New Jersey) drilled two wells in 1946 and 1947 a short distance west of Cairo, within sight of the pyramids. One of these wells entered crystalline basement rocks at

Continued on Page 246

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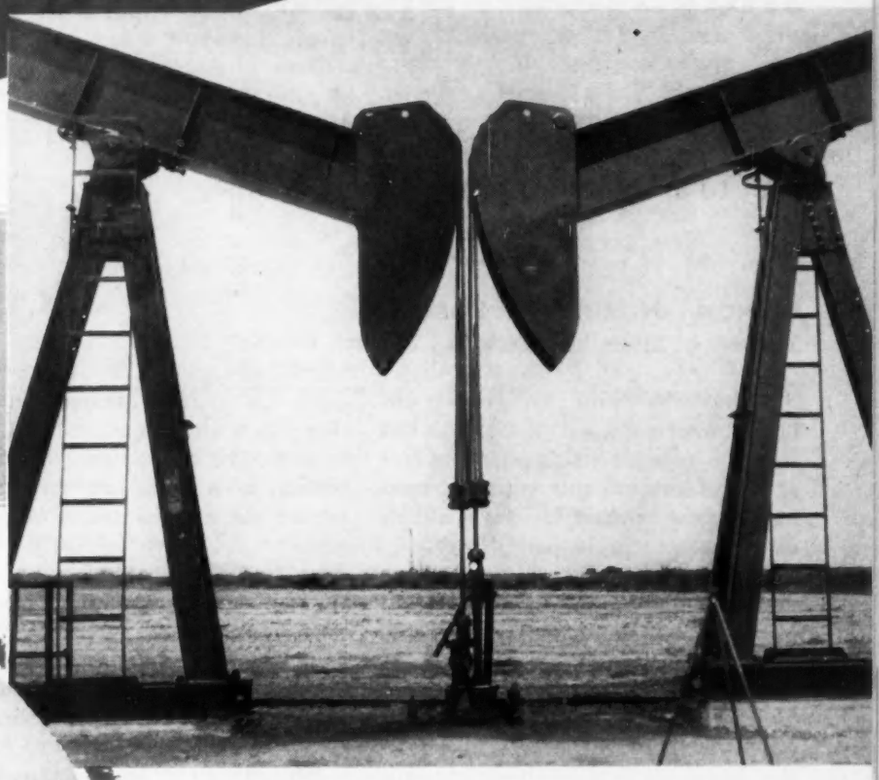

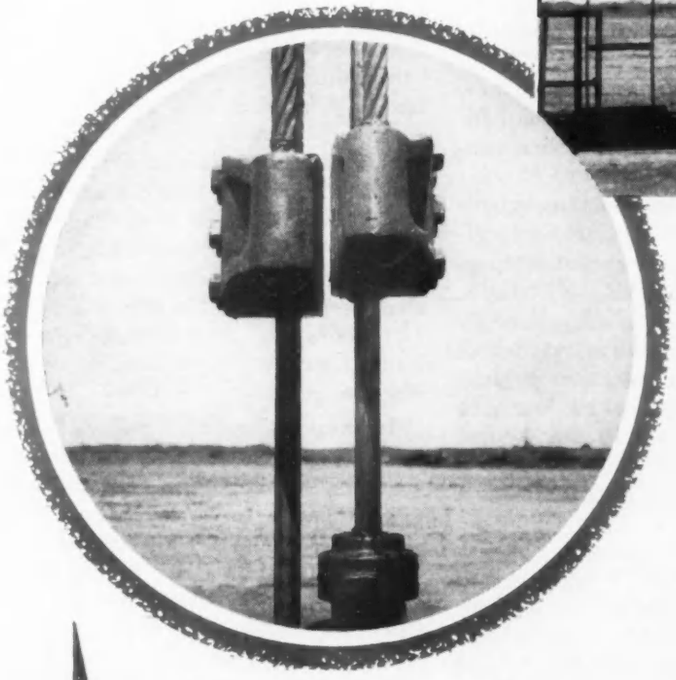

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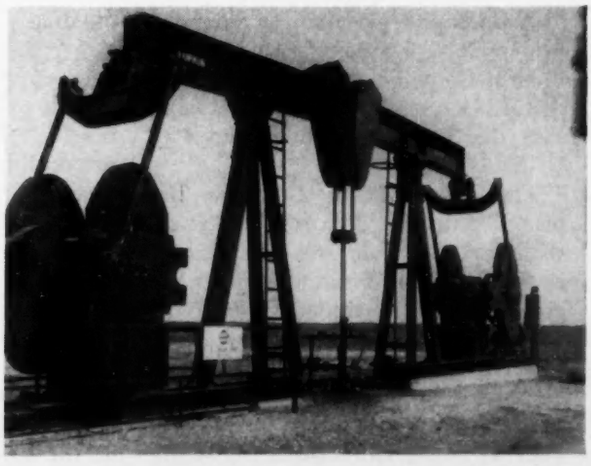

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Canadian Gas Line Delay May Mean Bigger Project

Spill-over into New York state called important to an economic Trans-Canada line.

By HON. GEORGE PRUDHOM,
Minister of Mines and Technical Surveys, Ottawa

COINCIDENT with the greatly enlarged reserves of oil in Canada has come a remarkable increase in reserves of natural gas with an even more urgent demand for markets than now is present in the oil industry.

Many parts of Canada can use gas advantageously at a price that will give fair return to the producer in western Canada. There has been considerable rivalry among various companies to be given permits to export gas from the Province of Alberta to the large markets within economic reach. The choice of the provincial authorities for the larger markets has been Westcoast Transmission Company and the amalgamated company of Trans-Canada Pipelines Ltd., and Western Pipelines Ltd. operating under the name of Trans-Canada. The Westcoast company has proposed to build a pipe line for gas from the Peace River area of Alberta and British Columbia, through central British Columbia to Vancouver, and into the Pacific Northwest area of U. S.

The Trans-Canada Company has proposed a line to central Canada with an extension into the Minneapolis area. Those familiar with negotiations are aware of some of the difficulties encountered. Westcoast received approval of the Board of Transport Commissioners in Ottawa. After lengthy hearings before the Federal Power Commission in Washington, however, it was denied the right to import gas into U. S. The franchise to supply the Pacific Northwest area of the U. S. was given to Pacific Northwest Company, which proposed to bring gas from the San Juan field in New Mexico. This decision was a disappointment in Canada because the Canadian government, insofar as it could do so, had supported the application of Westcoast.

Awaits FPC Ruling. Undeterred by this unfavorable decision, Westcoast made a deal with the Pacific Northwest Company. Arrangements now completed await sanction of the FPC in Washington before pipe line construction can commence.

This might again seem a formidable obstacle in view of the former application denial. Formerly, there was the objection of making the U. S. Pacific Northwest area solely dependent on a source in Canada over which U. S. officials could exercise no jurisdiction. This objection now has been removed in that the Canadian source of supply will be but a part of a larger project which also embraces a U. S. supply.

It is to be hoped the new application will be granted. If so, a larger project than originally planned for Peace River gas is likely to result with mutual advantages both to U. S. and Canadian consumers. There is no doubt of the benefits this project will bring to many people on the west coast of Canada. Without sales of gas to the U. S., any pipe line project to supply consumers in the Canadian west coast alone would be uneconomic as the volume of sales would be too low for the expenditures involved in pipe line building.

In regard to the Trans-Canada project, the policy of the Government of Canada was stated by the Rt. Hon. C. D. Howe, in the House of Commons on March 13, 1953, and has been several times reiterated by him and by other members of the Cabinet, including the prime minister.

This statement of policy makes it clear that no further export permits of gas from Canada would be granted until the needs of Canada, present and future, had been met. This is fulfilling the responsibility of parliament to see that the needs of the Canadian consumer are protected in the same way as the Alberta government declared that no export permit would be given from that province until the needs of its citizens for gas were assured for a period of 20 years.

Canada Criticized. There has been criticism of the position taken by the Canadian government that the pipe line route should be north of the Great Lakes. But one needs to make no apology for such a policy when the interests of Canadians is being best served. The Department of Mines and Technical Surveys is well informed as to the prospects and potential markets for gas through northern Ontario. It knows that this route, and its probable sales of gas, offers many advantages despite some of the difficulties of terrain and greater distance to markets than a route south of the Great Lakes. A gas pipe line built through northern Ontario can bring inestimable benefits not only to that area but also to the people of Canada whose general prosperity is but the sum of the prosperity of individual parts.

In enunciating such a policy of pipe line route, it should not be thought that the Canadian government was not prepared to consider doing its share in making the route as economic as any other, so that the producer would not be penalized by a lower price for his gas or the consumer forced to pay a larger price as a result of higher construction costs. It has consistently encouraged the initial operations of oil pipe line building both in respect to Interprovincial pipe line and to Trans-Mountain pipe line and it is prepared in the same manner to support other initial gas pipe line projects.

Trans-Canada experienced understandable difficulties in financing its proposed line. The first essential for any pipe line is throughput. With this assured, the financing is a matter of the earning power of the pipe line.

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Profit of any pipe line enterprise can be calculated by subtracting from the value of sales the cost of the product at the field plus the cost of transportation, maintenance and depreciation. If reserves are adequately established and if the cost of transport can be closely appraised from experience elsewhere, then a buying and a selling price can be established which will insure protection for investment funds. The buying price, of course, must be adequate to insure that it will warrant development by the producer. The selling price must be sufficiently low to insure a market that can be built up substantially in as short a time as possible.

Difficult Years. With all new pipe lines into areas of undeveloped gas markets, the first few years are likely to be somewhat difficult. This was recognized in negotiations between Trans-Canada and the Canadian government. If early markets are too small in central Canada to justify the largest pipe line that will give the most economic results, a spill-over into New York state should be a component part of the project. This would be advantageous to central Canada as well as New York state because obviously the greatest economies would be achieved by using the whole pipe line to near capacity. Thus, export at the end of the line is more attractive than export at intermediate points. This would be comparable to the Westcoast project. There, export into the U. S. Pacific Northwest must be an integral part of any gas pipe line built to Vancouver to achieve a more economic result.

Similarly the spill-over into New York state would make possible a very advantageous arrangement for Canada in that gas might be taken on a storage interruptible basis. This means that in summer months and on holidays and week ends when consumption in central Canada is low, a spill-over into storage in New York state would enable the line to function at capacity. Delivery need not be made during the peak consumption periods provided the volume delivered in off-peak periods fulfills contract specifications on the basis of a stated amount of delivery per year. Such an arrangement need not interfere with large interruptible deliveries in industry in central Canada. Nor need it interfere with storage of gas in off-peak periods to the storage fields of southwestern Ontario, where a supply to meet winter peak demands can be maintained.

It is regretted that Trans-Canada has met with such difficulty in carrying out the building of a gas pipe line to central Canada because results, both to the producer who needs a market and to the consumer who desires gas, could be equally beneficial. No one, however, need despair of the ultimate outcome. Various studies have indicated the pipe line project can be economical, and as such it is attractive to build. Loss of this summer's construction period is one of the bad features of the failure to get building under way. Perhaps, when all the difficulties are finally resolved, a better pipe line project will emerge.

Sources of energy are the keys to unlocking of Canada's great natural resources. It is now generally recognized that those countries with abundant energy can regard their future developments with confident assurance in their destiny. The gas resources in western Canada only await a market, and there certainly is a potential market in central Canada ready to use large volumes of gas.

ACKNOWLEDGMENT
Excerpted from a paper "Pipe Lines and National Program" presented at the Fourth Annual Oilwell Drilling Safety Clinic, Banff, Canada, and sponsored by CAAODC.

Israel's Discovery Well to Undergo Tests

Continued from Page 232

there has been a recent scramble for concessions, with about a dozen companies participating.

Nearest production to the indicated Israel strike is about 200 miles to the south, on the Sinai peninsula of Egypt.

Economically, this event has significance far more important than the completion of one oil well. Israel currently imports $36 million worth of oil and petroleum products, and the country is short on foreign currency. The national economy could be strengthened greatly if relieved of this burden. In addition, domestic oil and gas production could serve as a springboard for development of magnesium and copper, production of which requires cheap power.

Crude from the Huleiqat discovery probably would be processed at the Haifa refinery.

The Israeli Petroleum Law provides a royalty of one-eighth, entitles a company making a discovery to a 30-year lease on the developed area, renewable for 20 years.

Lapidot-Israel Petroleum Company, Ltd., is 31 percent American owned. The American group (AMPAL), headed by Abraham Dickenstein of New York City, is the parent company of Israel Petroleum Corporation, which owns this interest in Lapidot. The remaining 69 percent is owned by Mekorot Water Works, Ltd., of Tel Aviv. —**The End**

Second Baku Focal Point of Russian Oil

Continued from Page 238

cially high during the winter when Bashkiria's dirt roads are impassable. Exploratory work also lags badly during periods of snow, rain and thaw.

Pravda also says Bashkiria's oil exploration crews almost never use automobile transportation in the winter. Even in the dry season, tractors are favored for long trips.

"All this delays exploratory work and is expensive to the state. Large road construction organizations must be set up in Bashkiria to improve transport conditions."

The Communist party organ, in charging that many of Bashkiria's wells are needlessly idle, said:

"On some wells repairs are not made promptly. Operations at new wells often fail to begin for several months after drilling has been completed. Large amounts spent on building the wells are tied up in this way. Yet, managerial personnel seems undisturbed by the situation.

"Utilization of gas obtained in oil extraction has not been organized in the Bashkiria fields. Part of this valuable fuel is still burned off uselessly although it could be used to meet all the needs of Ufa, Chernikovsk, Oktiabrsky, and other heavily populated points.

"Bashkiria's refining industry has not done enough to improve its operations. The variety of petroleum

products made available to agriculture is still limited. Output of lubricants is not correctly organized. Industrial waste is not being utilized, and there are great losses in the refining process."

Pravda added that while living conditions in the Bashkiria oil field have improved during the past few years, construction of houses, schools, stores, and entertainment facilities still "lags sharply behind need." It claimed that the USSR Ministry of the Oil Industry and officials of the Bashkir Autonomous Republic "either take on interest at all or a very superficial one in the problems of housing and cultural construction for oil workers and their families."

Wartime Mines

Continued from Page 240

about 6500 feet. Oil shows were reported in hard, massive limestones in the Jurassic-Cretaceous section, but favorable porosities and permeabilities were not found.

Both tests were dry holes. Later, Standard dropped its 6 million-acre exploration permit, when the Egyptian government failed to enact favorable legislation. The new Cities Service concession, operated by Egyptian-American, includes the surface structure on which these two negative tests were drilled.

The oil possibilities of western Egypt are virtually unknown. A number of problems will be investigated. One such problem is the structural reasons for the existence of the Kattara depression, an area of about 5000 square miles, located in the south central part of the Conorada concession. It reaches a maximum depth of over 200 feet below sea level.

Water will be a serious problem in all operations. It is hoped that sufficient water for drilling can be acquired from drillsite wells, but portable water will have to be transported for virtually all operations.

Pemex Announces Sale of Natural Gas to the U. S.

Petroleos Mexicanos, government oil monopoly, has announced the largest natural gas sale of its history with a contract to supply at least 100 Mmcf of natural gas daily to the U.S.

The contract with Texas Eastern Transmission Corporation of Shreveport, La., will amount to between $125 million and $250 million dollars. It calls for Pemex to sell between 100 Mmcf and 200 Mmcf of natural gas daily during the next 20 years. The gas will come from fields in the Lower Rio Grande valley around Reynosa.

Pemex will receive 14.2 cents (US) per thousand feet at the start of the contract, with the price rising annually. The gas will be processed at the Pemex absorption plant at Reynosa and moved north and east in the U. S., eventually reaching the New York area.

Pemex's announcement of the sale emphasized the natural gas is surplus which cannot be consumed by Mexico. Most gas used in Mexico is liquefied butane. This comment apparently was aimed at heading off domestic criticism of the sale of natural resources abroad.

Pemex said it has 22 gas fields in the area and that three of them will suffice to fill the Texas Eastern contract.

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a WORLD of OIL

By **DON KLIEWER,** World Oil Staff

Alaska: The $40 million, 625-mile oil pipe line designed to provide oil products for the interior is nearing completion. Terminal of this pipe line, undertaken as a project by the Army Engineers, is at Fairbanks.

Albania: An agreement has been signed with Poland for exchange of crude and gasoline for Polish drilling rigs.

Austria: Newly-formed Austrian Petroleum Administration has taken over 660 producing wells from the Soviets, yielding a total of about 67,000 barrels daily; therefore, daily average production per well amounts to about 100 barrels in the fields hitherto under Russian administration . . . It is reported that the newer oil fields were left by Russians in good condition, but the old field at Zistersdorf has been neglected . . . Too, since the Russians kept all records in their native language, months will be required for Austrians to make the necessary translations . . . Since oil field workers represent the core of the Communist party in Austria (20 of 22 Peoples' Councils in the fields are Communist or Communist-dominated), they are still able to exert serious pressure if they desire; however, the government intends to get rid of the troublesome elements.

Bahrain: California Texas Oil Company, Limited, produced 903,339 barrels of oil in September.

Canada: Rising demand for Alberta oil on Canada's west coast and in Washington State will keep the throughput of Trans-Mountain Pipe Line in excess of 100,000 barrels daily for the second consecutive month . . . Texaco Exploration Company has brought in a 71-barrel-daily flowing well—the first Cardium discovery for the Bonnie Glen area—at 3848-3855 feet . . . Alberta's natural gas reserves now have been estimated at 15.6 trillion cubic feet . . . Imperial Oil Ltd., will explore Prince Edward Island under a 500,000-acre license issued by the government . . . The deepest well ever drilled in Canada, a dry hole in Hillsboro Bay, near Charlottetown, the principal town on Prince Edward Island, was abandoned at 14,686 feet.

Cuba: Nine rotary and 14 cable tool rigs were active at the close of September, with footage for the month amounting to 28,283 feet, according to *Cuba Petroleum News Digest* . . . Exploration and development of 90,000 acres of land recently acquired in the Pinar del Rio province by Cullen Minerals Corporation will be conducted by a wholly-owned Cuban subsidiary.

Colombia: New decree law establishes 50-50 profit-sharing and increases depletion allowance in effort to attract oil investment.

Czechoslovakia: Delivery of "large amounts" of seamless line pipe to Yugoslavia will be made for the first time. Heretofore, the Czechs have not been willing or permitted by Moscow

Here is what TK-2 plastic linings have done for some oil companies . . .

A Texas company installed 3,000′ of 2″ pipe lined with TK-2 plastic in a 7,500′ well pumping 175 bbl of salt water and 60 bbl of oil per day. Bottom hole pressure was 2800 psi and bottom hole temperature was 233° F. After five years the Tube-Kote lined pipe was still giving excellent service.

Another company put a salt water disposal system into operation with 3″ down hole pipe lined with TK-2 plastic and 3,000′ of 4″ uncoated surface pipe. In eight months the uncoated pipe had to be replaced. Well was pulled after a year and the 3″ pipe lined with TK-2 looked as perfect as the day it was installed.

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Pioneers in plastics since 1939 . . . manufacturers-extruders of plastic pipe for the oil industry. Factory trained field engineers available for consultation in all principal oil areas.

(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

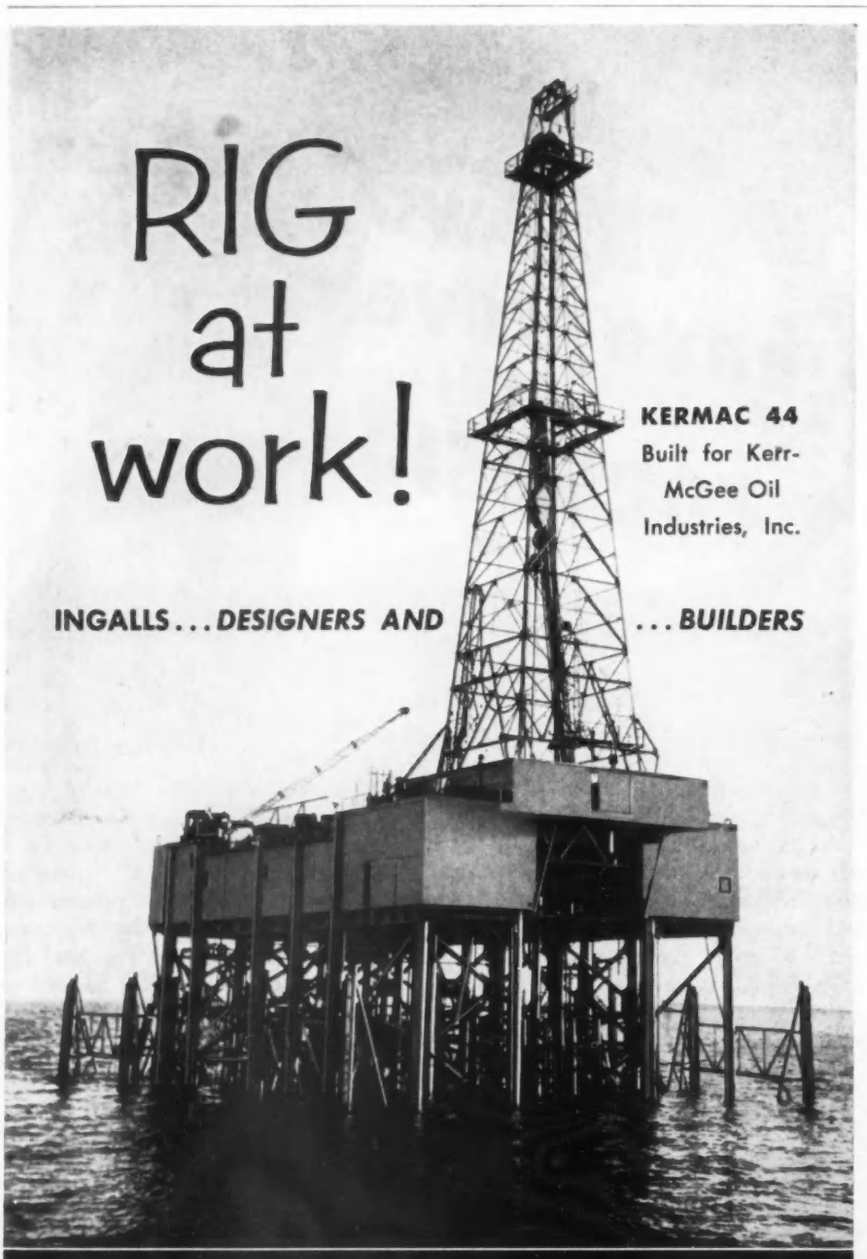
to export such scarce, essential goods to Yugoslavia.

Egypt: Egyptian-German Petroleum Company, recently organized, has obtained an oil exploration concession on the Sinai peninsula and will negotiate for a similar concession in Transjordan.

France: American Overseas Petroleum France SAF and Societe Nationale des Petroles du Languedoc Mediterranean will put two seismic crews in the field immediately to survey their 7722-square-mile concession south of Paris. Caltex owns Amofrance; SNPLM is French-owned.

Great Britain: Nearing completion is a 10,000-square-mile aerial magnetometer survey of the Midlands area for Nuffield Foundation.

India: Assam Oil Company has completed Well 970 in the East Kharjan area of Digboi field as the area's best producer to date . . . Nahorkatiya 7, recently completed in 48 days, is the fastest drilled well in India.



THE INGALLS SHIPBUILDING CORPORATION

Two Shipyards: Pascagoula, Miss., and Decatur, Ala.
Offices: BIRMINGHAM, ALA., New York, Pittsburgh, Washington, D. C., Chicago, New Orleans, Houston, Philadelphia, Atlanta

Indonesia: California Texas Oil Company, Limited, produced 1,918,269 barrels of oil during September.

Iran: A newly-commissioned multi-stage stabilizer production unit at Agha Jari oil field has boosted the annual crude output potential of the field by about 115,000 barrels daily to 480,000 barrels a day.

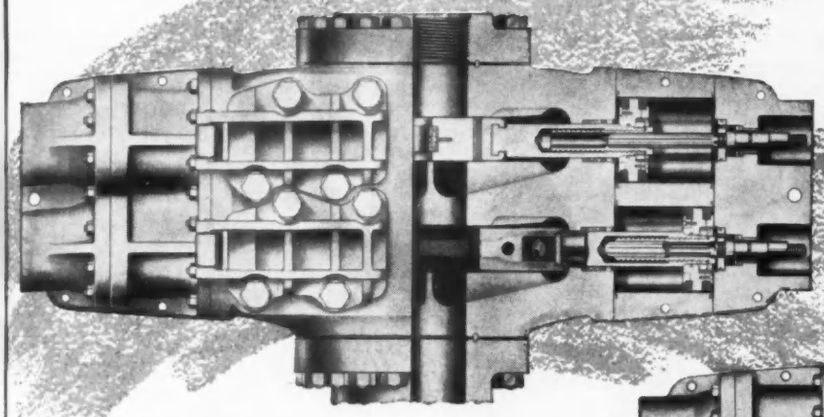
Israel: Lapidot & Associates' Massada 1 stopped drilling at 5275 feet pending formation testing for natural gas . . . Israel Continental Haifa Bay 1 has run 3252 feet of 9⅝-inch casing and was drilling ahead at 4920 feet with 8¾-inch bit . . . Israel-American and Associates' Gan Yavneh 1 was abandoned as a dry hole at 3504 feet and the Petah Tiqva test was abandoned at 9000 feet as dry. Directors of the company were in the U. S. to plan the 1955-1956 drilling program and to discuss technical problems and financing . . . Pan-Israel and Israel-Mediterranean test at Kurnub was in hard sandstone of Lower Jurassic at 8650 feet and the first string of casing —2000 feet—had been run in when derrick overturned in lifting operation. A new drilling rig with a 133-foot mast was borrowed from Lapidot.

Kuwait: Kuwait Oil Company, Ltd., reports August crude production amounted to 32,342,173 barrels.

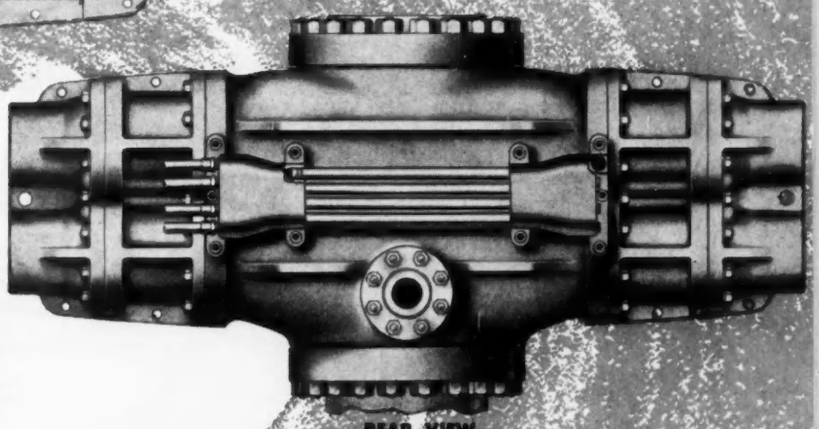
Mexico: Latest crude production figures from the government: for the period January through June, 45,692,000 barrels; average per month during the period, 7,615,000 barrels, as compared with average monthly yield during 1954 of 6,971,000 barrels . . . Recent hurricanes sank the tanker Cerro Azul in Tampico harbor, but it will be restored to service . . . A new well producing a reported 30,000 barrels daily has been completed by Pemex, the government monopoly, in Poza Rica region of Veracruz state. The well, Santa Agueda 49, was one of five being drilled in the area . . . Well 34 in Angostura is completed and producing oil.

Nigeria: The 11th well to be drilled in Nigeria by Shell-D'Arcy Petroleum Development Company of Nigeria Ltd., has been spudded in at Umuna, in Owerri Province.

 (For more data on advertised products, use Readers' Service blue cards, last page this issue.)



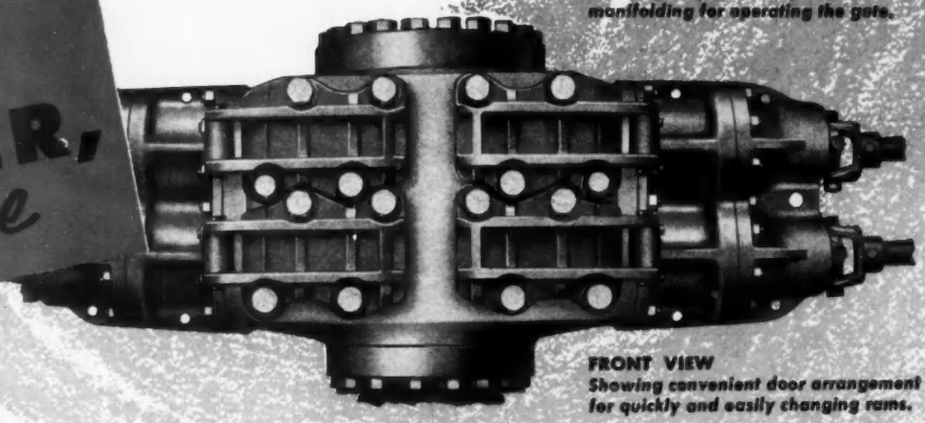
CUTAWAY VIEW
Showing direct hydraulic drive and self-draining ram compartments.



REAR VIEW
Showing simplicity of hydraulic manifolding for operating the gate.

—the industry's Most Advanced cellar control gate

it's **SHAFFER,** *of course*



FRONT VIEW
Showing convenient door arrangement for quickly and easily changing rams.

Here's Why

Shaffer, the organization that pioneered Cellar Control Gates over a quarter-century ago, has continually led in new control gate advancements. And today's Shaffer Hydraulic Cellar Control Gates embody features that are *years-ahead* of the industry—features developed by Shaffer and found in Shaffer Gates *exclusively!*

SIDE-OPENING DOORS are a very important—*and exclusive*—Shaffer advancement. To change rams simply unbolt and swing the doors open—change rams—then bolt the doors shut again. *It's as simple and quick as that!*

But simplicity is only part of the story. There's no need to allow extra space above or at the ends of the Gate to change rams. The doors open across the *shortest* dimension where there's plenty of room to work. Therefore, the compact over-all dimensions give *compactness that really means something* —"fixed-dimension" compactness!

AND ANOTHER IMPORTANT FEATURE is the fact that you can change rams in either compartment of a Shaffer Hydraulic Double Gate without in any way disturbing the other compartment. There's no need to dismantle the upper compartment to change rams in the lower compartment—or vice versa. Each compartment has its own side doors and is completely independent of the other.

And remember—rams in either or both compartments can be changed with equal ease whether the pipe is *in* or *out* of the well!

When you buy cellar control gates you want SAFETY—and no equipment equals the field-proven dependability of Shaffer Gates, built by *pioneers* of such equipment. But don't stop at safety alone—look for the added features that make the big difference in cellar control gates—*the years-ahead advancements you get in Shaffer Gates!*

See your nearest Shaffer representative for complete details — or write direct.

Want a copy of the latest Shaffer catalog? It's free.

See the Shaffer section of your Composite Catalog.

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

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FARMINGTON, NEW MEXICO, Shaffer Tool Works, Post Office Box 546
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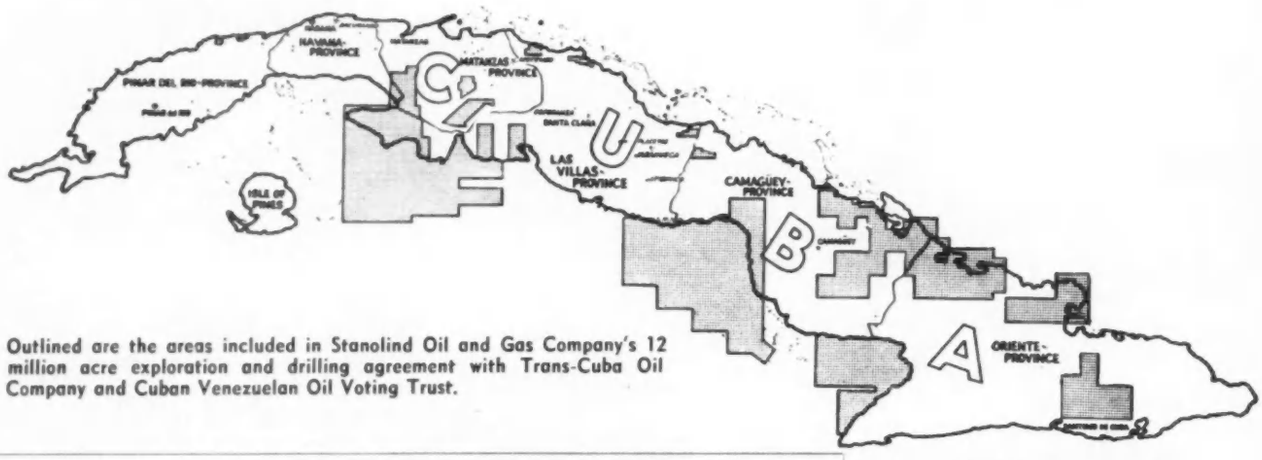
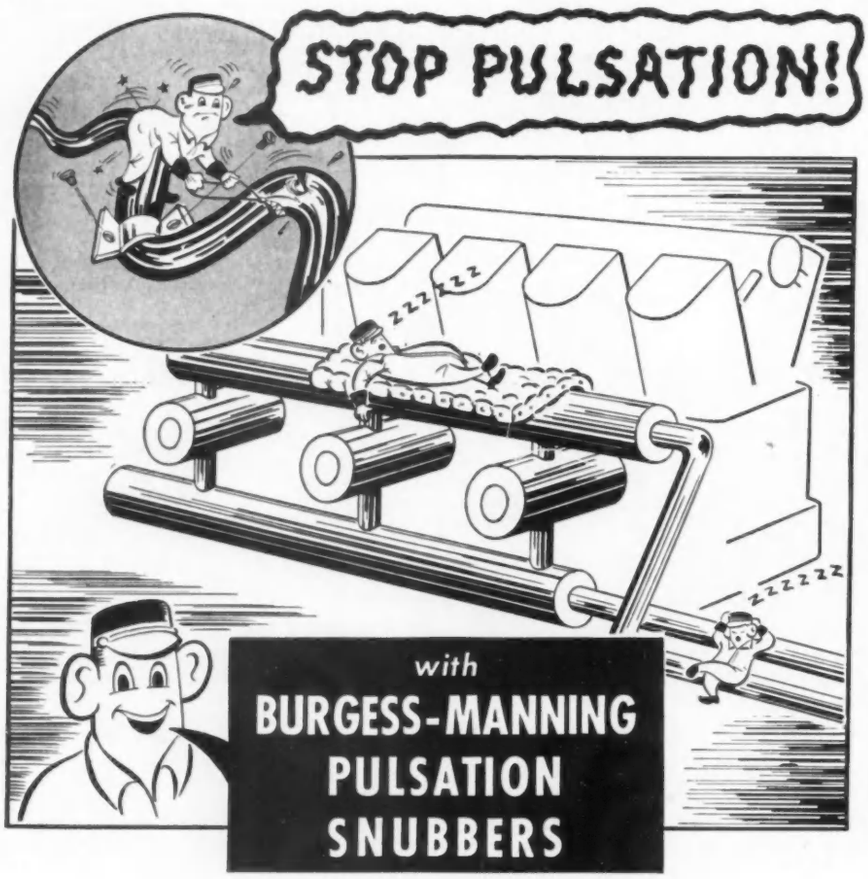
32 years OF OIL TOOL LEADERSHIP



Outlined are the areas included in Stanolind Oil and Gas Company's 12 million acre exploration and drilling agreement with Trans-Cuba Oil Company and Cuban Venezuelan Oil Voting Trust.



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Burgess-Manning Pulsation Snubbers will remove one of your most aggravating and costly bug-a-boos, that of line surges from compressors, pumps, blowers, etc. Maintenance and service costs will drop sharply — lines and associated equipment will operate at a new efficiency — flow control can be greatly improved. Structural supports of pipe lines need no longer be of costly and special construction — gas compressors and pumps will deliver full design flow with greatest efficiency in pulse-free piping.

Send us your specifications for recommendations

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Stanolind Seals Pact For Cuban Exploration

Contract negotiations for Cuba's largest oil exploration program have been completed between Stanolind Oil and Gas Company and two Cuban oil firms. Involved in the exploration and drilling plans are about 12 million acres of concession rights on the island.

Under terms of the contract, now in effect, Stanolind could spend as much as $10 million in a five-year period. Generally, the flexible contract provides that Stanolind must spend at least $2 million in exploration and drilling by January 1, 1957, to keep the agreement in force.

Concession rights to areas included in the agreement are held by Trans-Cuba Oil Company and the 24 companies managed by Cuban Venezuelan Oil Voting Trust. Areas are located largely along the south side of the island, and cover both onshore and offshore portions of Matanzas, Las Villas, Camaguey and Oriente Provinces.

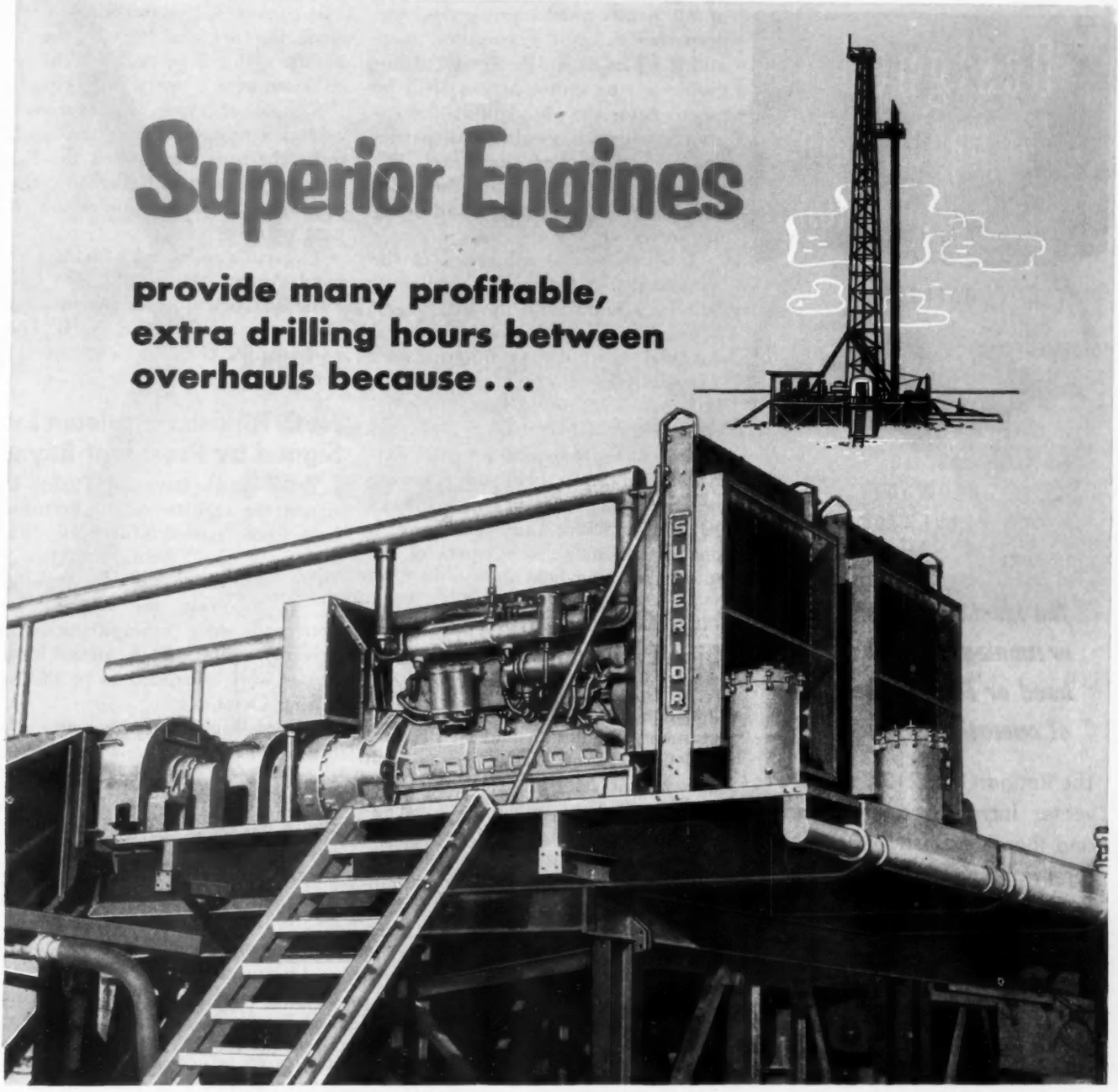
During each 12-month period after January 1, 1957, Stanolind may at its option continue the agreement by drilling 40,000 feet of exploratory hole or by spending $2 million for exploration, including drilling. At any time the company's total expenditures reach $10 million, it will earn a half interest in concession rights on the entire 12 million acres covered in the agreement.

Subject to a forfeit penalty, Stanolind may withdraw from the program at any time; however, for any producing well brought in, the company will retain 50 percent interest in the well and in about 80,000 acres around the well.

Stanolind, which will be operator

Superior Engines

provide many profitable, extra drilling hours between overhauls because . . .



Superior Diesel or Dual Fuel Drilling Engines are available from 300 to 650 Continuous B.H.P., Superior Gas Drilling Engines from 320 to 630 Continuous B.H.P.

Great engine accessibility and simple rugged construction make routine maintenance quick and easy—right on the rig! Features such as dynamically balanced crankshaft, heavily reinforced cylinder block, individual cylinder heads and fuel pumps for greater dependability, and sturdy engine bed which takes the Diesel firing thrust, to mention a few, greatly lengthen the time between engine overhauls.

Case histories prove, when Superior engines finally need overhauls, they require few major part replacements . . . down time and maintenance costs are cut to a minimum.

Buy Superior Engines and you make a superior investment! Get all the facts from leading rig manufacturers, or through White Diesel field representatives available in all oil field areas or through White Diesel Engine Division.

WHITE DIESEL ENGINE DIVISION

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Designed
for Handy, Safe
Operation

RATIGAN

No. 212
BLOWOUT
PREVENTER

The ideal tool for swabbing or running rods in wells that head or flow in the course of operation.

The Ratigan No. 212 Blowout Preventer increases operator safety and there's no more efficient unit for swabbing than two of these Ratigan Blowout Preventers of the same size, with a nipple of any required length between them.

Made of high-pressure electric steel, and although tough and rugged, the No. 212 is light in weight, and has a capacity of 3,000 lbs. Equipped with retractable rubbers, they can be easily and quickly changed by merely unscrewing plugs at each end.

Available in 2", 2½" and 3" sizes.

SOLD THROUGH LEADING SUPPLY STORES EVERYWHERE

J. P. RATIGAN, Inc.
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Export: National Supply Co., Inc., Export Div.
600 Fifth Ave., New York 20, N.Y.

of all jointly-owned properties, was preparing to begin exploration operations immediately. Aerial photographs of the entire acreage will be taken. After the photographs are examined, surface geological parties will investigate promising areas. The extensive geophysical program also will include seismograph and magnetometer surveys.

A wholly-owned subsidiary of the Standard Oil Company (Indiana), Stanolind ranks with the five largest domestic producers of crude, natural gas and natural gas liquids, with operations in 16 states and Canada. If commercial production is discovered in the Cuban venture, the program will be Stanolind's second outside the U. S. In 1948, the company began exploration work in Canada's Alberta province, and currently is one of the major developers of the major Pembina field there.

Hunt Organization, Pakistan Sign Exploration Agreement

Two oil exploration agreements have been signed between the Government of Pakistan and N. B. Hunt and C. L. Hunt, Dallas, Texas, each of which covers an area of 10,000 square miles.

The Hunt organization reportedly proposes to send drilling and exploration equipment to Pakistan immediately and to commence drilling operations as soon as possible. Areas to be explored lie along the coast of the Arabian sea, west of Karachi toward the Iranian border and in the Indus river valley, north of Karachi.

Terms of each agreement reportedly provide that the Pakistan government will share in the risks of exploration through a 25 percent participation in exploration costs. On this basis, the Pakistan government has agreed to invest funds as required up to a maximum of $5,250,000 under each agreement. Both pacts incorporate the depletion allowance clause which, together with other financial provisions, will result in the sharing of any resulting profits on a 50-50 basis.

The Pakistan government will share in ownership of any oil and gas discovered on the same basis as its participation in exploration costs. The pacts further provide that the Hunt organization will purchase the government's 25 percent share of oil at its wellhead value.

If commercial production is discovered, the organization proposed to discuss with the government the construction of a refinery in Pakistan.

Signing of these two agreements extended to a total of 40,000 square miles the area over which the Pakistan government has granted concessions for oil exploration within the past year.

Pakistan's ambassador in the U. S., Syed Amjad Ali, signed the agreements on behalf of his government. Other signatories were N. B. Hunt and John A. Goodson, who signed on behalf of C. L. Hunt.

New Turkish Petroleum Law Signed by President Bayar

President C. Bayar of Turkey has signed the regulations for Petroleum Law 6326 (passed March 16, 1954) and Law 6558, published May 21, 1955, containing amendments designed to make the nation's new petroleum code more attractive to private capital. Applications for licenses were scheduled to be received during October.

Eleven companies are actually on the ground and are known to be ready to apply for licenses.

Currently disturbing to Turkey is the recent experience of Libya. There, except for two tracts in the Sahara desert, all coastal or near coastal license applications overlap, resulting in the need for action by the Libyan government to clear up the conflict.

To prevent a similar conflict, Turkey has taken several steps, including:

- To limit the number of accepted applications.
- To permit companies themselves to settle any conflicts which may arise, and, should that fail, to require that companies indicate order of preference.

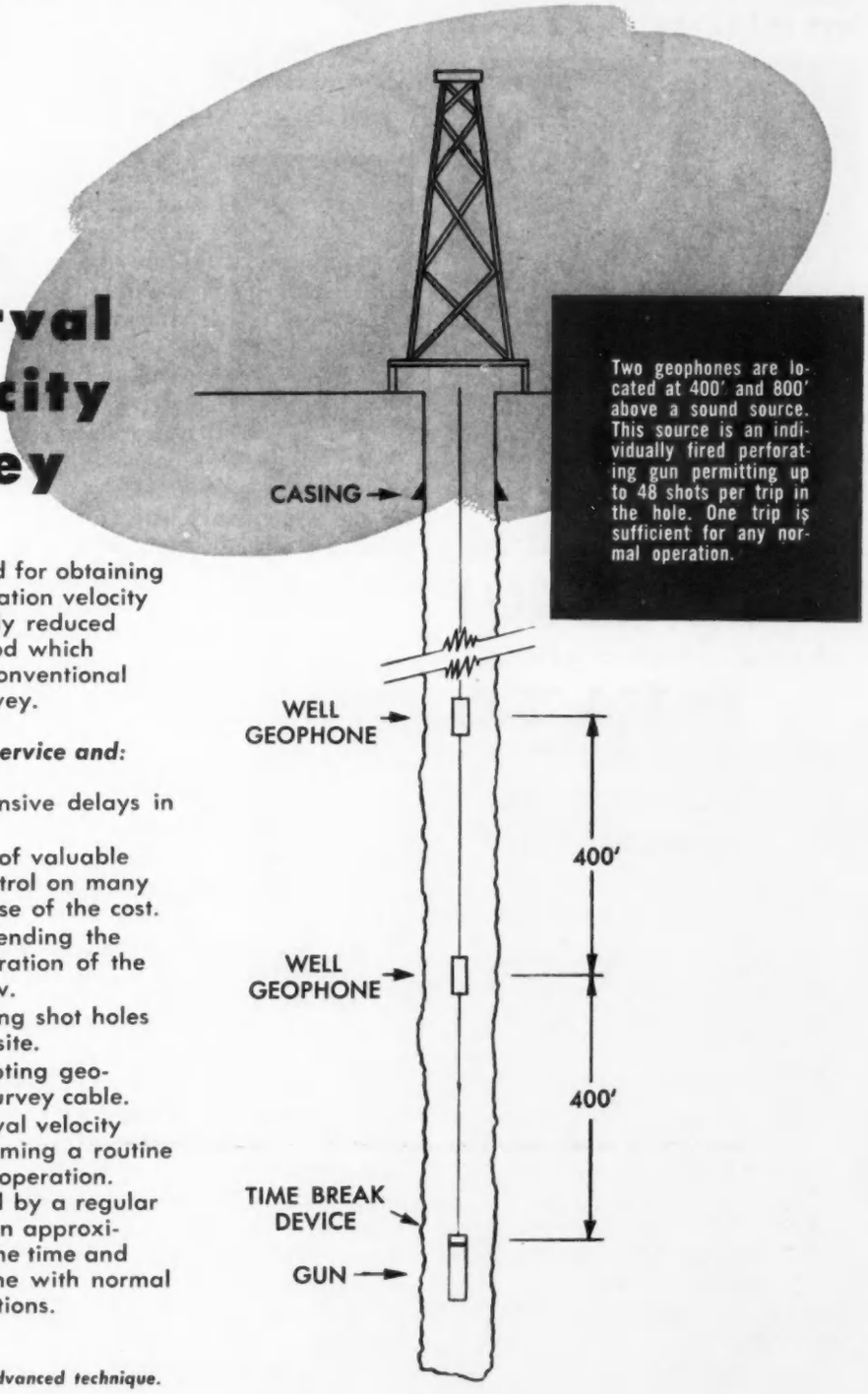
New Costa Rica Test Well Is Called "Encouraging"

Compania Petrolera, S.A., Union Oil Company of California subsidiary in Costa Rica, reports "encouraging" its new test well, Bris 1, which was spudded August 23. The test was drilling ahead at 1200 feet at the beginning of September.

Bris 1 is located about 15 miles south of Patino 2, which was abandoned recently at 10,128 feet. Another well also was abandoned during the year at a depth of below 10,000 feet.

SCHLUMBERGER ANNOUNCES

the long interval velocity survey



Two geophones are located at 400' and 800' above a sound source. This source is an individually fired perforating gun permitting up to 48 shots per trip in the hole. One trip is sufficient for any normal operation.

A new method for obtaining accurate formation velocity data at greatly reduced cost — a method which replaces the conventional geophone survey.

Use this new service and:

AVOID — Expensive delays in rig time.
AVOID — Loss of valuable velocity control on many wells because of the cost.
AVOID — Suspending the normal operation of the Seismic crew.
AVOID — Drilling shot holes at the well site.
AVOID — Adapting geophones to survey cable.

The long interval velocity survey is becoming a routine Schlumberger operation. It is performed by a regular logging crew in approximately the same time and at a cost in line with normal logging operations.

Please write for additional information on this advanced technique.

SCHLUMBERGER WELL SURVEYING CORP.

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This OPENING and CLOSING motion....

LUBRICATES
your plug valves
AUTOMATICALLY
when you equip with....
DELTA
AUTOMATIC
PLUG VALVE LUBRICATOR

Engineers agree that plug valves should be lubricated each time they are opened and closed.

NOW they can be—automatically—by the adaption of this simple, fool-proof device, that never forgets.

Each time the valve is opened and closed a measured amount of lubricant is forced in. The reservoir holds enough lubricant for the valve to be opened 50 to 80 times, and is refilled in seconds with the Delta Gun.

The savings in time, trouble and valves will repay the small cost of this Delta Lubricator again and again. Write for details and prices.

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LUBRICANTS FITTINGS GUNS LUBRICATORS

What's Happening

AMONG WORLD OIL MEN

COL. JOHN M. KENDERDINE, of Midland, Texas, is presently commanding the Japan Quartermaster Petroleum Depot in Yokohama, Japan. That organization operates a vast petroleum terminal storage and distribution system throughout Japan and furnishes all petroleum products for the Army, Navy, Air Force, Marines, and other U. S. agencies in the Far East.

J. M. Kenderdine

Col. Kenderdine is a Texas A&M graduate in petroleum engineering and was formerly with Gulf Oil Corporation.

•

C. K. SHEPHERD, Denver, has been appointed manager of exploration for Egyptian-American Oil Company, a subsidiary of Continental Oil Company. Formerly regional geophysicist for Conoco's Rocky Mountain region, he will make his new headquarters at Cairo.

Egyptian-American Oil Company is exploring for oil on an 88,000-square-mile concession in Egypt.

Shepherd joined Conoco in 1937 and served on geophysical crews in several Rocky Mountain, midwestern and Southwestern states before his promotion in 1948 to geophysical supervisor at Lafayette, La. He was named Rocky Mountain regional geophysicist at Denver in 1950. A native of Eldon, Mo., he received his bachelor's degree in civil engineering from the University of Missouri.

•

H. J. VEENINK, chief engineer, Netherlands New Guinea Petroleum Company, Sorong, New Guinea, left the U. S. recently by air for a visit at his home in Holland after a tour of U. S. oil areas. He visited oil installations on the Pacific Coast, and in the Tulsa, Okla., Houston, Texas, and New Orleans, La., areas.

From Holland, Veenink was scheduled to return to New Guinea.

ARTHUR BENSON BROWN has become associated with Caltex as managing director, Caltex Pacific Petroleum Maatschappij, with headquarters in Djakarta. Brown, a former president of Richmond Oil Company, Lima, Peru, was with Richmond for 25 years.

ROBERT NELSON HARDING, another newcomer to Caltex, has been appointed deputy managing director of CPPM and will serve with Brown in Djakarta. Harding transferred to Caltex from The Texas Company, where for 18 years he was engaged in exploration work in the U. S. and Canada, as a computer, surveyor, field operations executive and, finally, superintendent of the Northern Foothills Project in Calgary, Canada.

•

FREDERICK WILLIAM DITTUS, chief engineer of California Texas Oil Company, Limited, since 1944, has been appointed an assistant vice president. A graduate of the University of California, Dittus has supervised construction projects in all parts of the world and is in charge of design and construction of refineries, pipe lines and other major facilities for the Caltex Group. He started with Standard Oil Company of California in 1916. In Europe, from 1935 to 1937, he was in charge of procuring all construction materials for the Bahrain Refinery.

•

D. M. WEST, formerly district geologist for Socony-Vacuum Oil Company of Canada, Ltd., at Edmonton, Alberta, has been transferred to Calgary to handle staff geological functions for Socony-Vacuum of Canada.

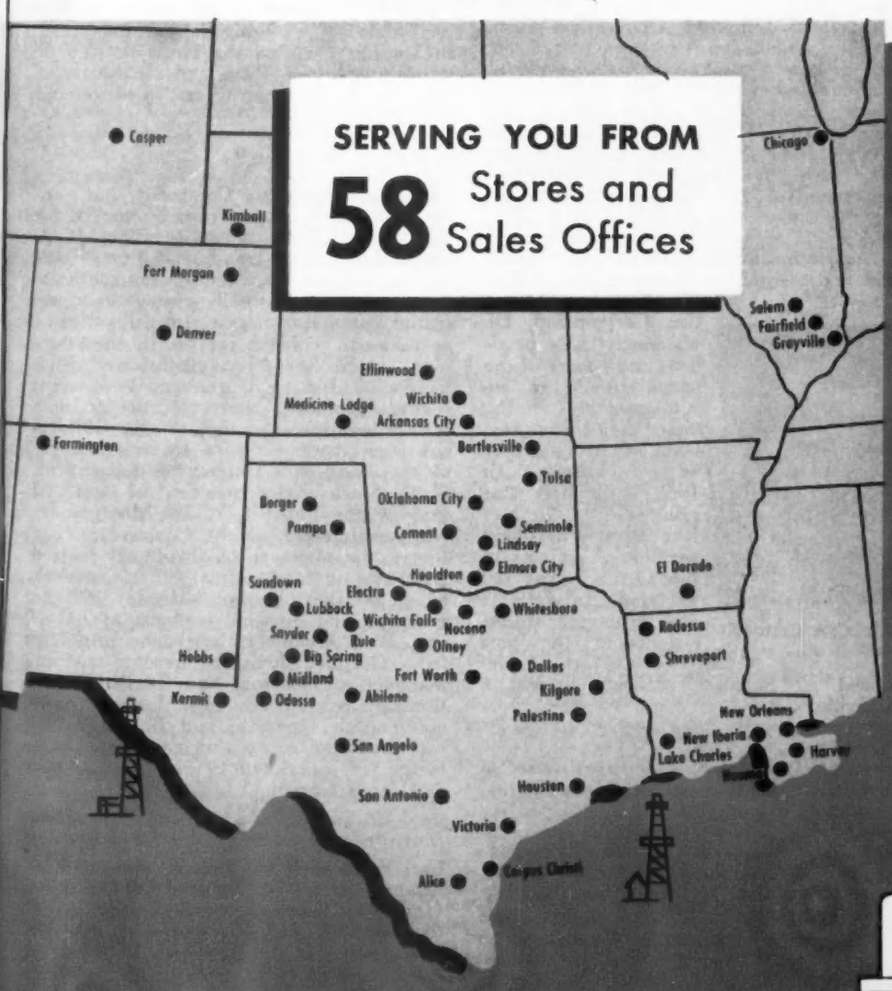
•

F. A. KIDD and L. O. WIRINGA have been appointed to senior geological posts with Shell Oil Company, Calgary, Alberta. Kidd recently completed a sixth-month assignment at The Hague. Wiringa served in Shell's Exploration department in Houston, Texas, and in Oklahoma, had two assignments at The Hague and spent two years in Venezuela with Shell.

THERE'S A *Flying "R"* NEAR YOU...

YOUR SUPPLY STORE

ready to RUSH the finest in production and drilling equipment to YOUR wells and rigs!



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—MEDICINE LODGE, KANSAS
—PAWHUSKA, OKLAHOMA

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What's Happening

AMONG MEN IN THE INDUSTRY

J. S. Leonard

N. E. Trumbull

Ohio Oil Company's Production department promotions recently announced include **J. S. Leonard**, assistant manager of Ohio Oil's Casper, Wyo., division, who was appointed manager of the Tulsa division. He succeeds the late Edward B. Stewart. **N. E. Trumbull**, division superintendent at Terre Haute, Ind., became assistant division manager at Casper, and **J. H. Shonk**, assistant division superintendent at Terre Haute, succeeded Trumbull. Leonard's first job with Ohio Oil was in Mexico as a junior geologist in 1930. He was made rotary drilling foreman at Reed City, Mich., in 1948; drilling superintendent at Houston in 1950; and district manager in Sidney, Neb., in 1953. He went to Casper as assistant division manager in 1954. Trumbull first worked for Ohio Oil in 1936 as a roustabout in Wyoming and later in New Mexico and Texas. In 1950 he was transferred to the South Coles Levee Cycling plant as assistant superintendent. He went to Terre Haute as division superintendent in 1952. Shonk started with the company in 1922 as a roustabout. In 1952 he was appointed assistant division superintendent at Terre Haute.

J. H. Shonk

•

Creole Petroleum Corporation recently announced the appointment of **Eleanor T. McNamara** as an assistant secretary of the corporation. She joined Standard Oil Company (N.J.) in 1944 as a stenographer in the Refining Coordination department; in 1946 she was transferred to Creole where she has held several secretarial positions. At present, she is secretary to **E. J. Mundy**, Jr., secretary of the corporation.

•

Charles J. Mellendeck has been appointed marine superintendent for **Tide Water Associated Oil Company's** eastern division. Joining the company in 1931, he served as engineer on the "S.S. Veedol II" and the "M.S. Tide Water". In 1936 he was named assistant to the marine superintendent. Succeeding Mellendeck as assistant marine superintendent is **Walter Kucaba** who joined Tide Water in 1947 as chief engineer. In 1953 he was named acting inspector of ship repairs.

C. W. Cargile of Oklahoma City, has joined **Barrett Drilling Company** to set up a geological department for that company. His headquarters will be in Shawnee, Okla.

•

The Southern Association of Science and Industry has selected **Dean A. McGee**, president, **Kerr-McGee Oil Industries, Inc.**, as the year's outstanding industrialist in the south. He recently was honored at a special meeting of the Oklahoma City Chamber of Commerce.

•

W. H. Garbade, president, **Crescent Corporation**, Tulsa, has been elected to the board of directors of the Minneapolis-Moline Company.

•

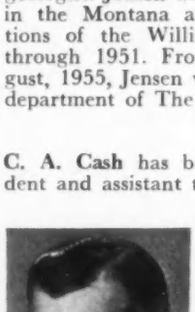
Dr. Hughes M. Zenor has been appointed head of the Geophysical department in the Petroleum Engineering school at the University of Tulsa. The University will offer a master of science degree in geophysical engineering.

•

Halbert & Jennings, Denver oil firm, recently announced the appointment of **Fred S. Jensen** to the position of regional geologist. Jensen worked with the U.S.G.S. in the Montana and North Dakota sections of the Williston Basin from 1946 through 1951. From 1952 until the August, 1955, Jensen was with the geological department of The Texas Company.

•

C. A. Cash has been elected vice president and assistant to the president of **The Shamrock Oil and Gas Corporation.** He was elected vice president and officer of the corporation at a recent meeting of the board of directors. Cash began his career with Shamrock in 1935 as a bulk station clerk at the McKee Plants and held various positions in the Operations department. In 1948 he was promoted to assistant to the vice president in charge of operations and moved to Shamrock's headquarters in Amarillo.



C. A. Cash

•

George J. O'Brien, vice president of **Standard Oil Company of California**, has been elected president and director of the Huntington Beach Company. He succeeds F. S. Bryant, who has resigned to become special assistant to the Secretary of Defense. O'Brien joined Standard's Marketing department in 1920 and later entered the Treasurer's department. He was named treasurer in 1940 and elected a vice president in 1943. He is and will continue as general representative of the company's Western Operating division in Southern California, with headquarters in Los Angeles. The Huntington Beach Company is a land and royalty organization in which Standard of California holds an interest.

John Edward May and **David L. Florence** recently announced the opening of the **Mayflo Oil Company**, a new brokerage firm dealing in oil and gas properties. Offices are in the Republic National Bank building, Dallas. May has been employed by the Republic National Bank, his last position being in the Oil Loan department.

•

Helmerich & Payne, Inc., recently announced the appointment of **Sam J. Brown** as contract representative of drilling operations. He was first employed by the firm as a roughneck in 1938. A graduate of the University of Tulsa, he also holds a Master of Business Administration from Stanford University and has course work completed for Ph.D. in Business Management from the University of Texas. During the past five years, Brown has been on the teaching staff of the University of Tulsa and University of Texas and has been doing management consultant work.

Sam J. Brown

•

Phillips Petroleum Company has announced the following promotions: In the Bartlesville, Okla., general office, **J. E. Kendall** has been transferred from Houston as regional manager for the southeast region. **R. E. McPhail**, promoted to assistant regional manager, also will continue as regional geologist for the southeast region. **J. H. Sneed** was transferred from Evansville, Ind., and promoted to assistant regional manager and regional landman for the southwest region. **S. K. Childers** has been made assistant to the manager of the Land and Geological department. **C. O. Stark** is vice president of land and geology for Phillips. **T. H. Montgomery** was transferred from the Bartlesville office to become manager of the newly-created Lafayette division office. **S. A. Spencer**, from Houston, became assistant division manager and division geologist at Lafayette. **R. J. Chambers** has been transferred from Corpus Christi to become division manager at Houston; **Sam McBirney** has become assistant division manager and landman at Houston; and **B. C. Phillips** was promoted to division geologist. **O. R. Keith** was promoted to division geologist at Corpus Christi.

•

Earl W. Russell has become executive assistant secretary of **Standard Oil Company (Indiana)**. Formerly assistant secretary of the company and administrative assistant in the office of the president, he has been transferred to the secretary's department. Russell joined Standard Oil in 1928 as a clerk in the Indianapolis sales division. He was promoted to administrative assistant in the president's office in 1946, and has served since 1952 as an assistant secretary of the company.

Harold W. Coryell

Howard E. McKinney

Harold W. Coryell has been appointed to fill the new position of patent liaison man in the Houston area for **Shell Development Company.** Coryell, who's office is at Shell's Exploration and Production Research Laboratory in Bellaire, Texas, is available to Shell Oil and Shell Chemical personnel in Houston to offer guidance in patent matters. An experienced patent agent, Coryell spent five years with the U. S. Department of Agriculture's Southern Regional Research Laboratory in New Orleans in addition to three years with Shell Development's Patent division. In September, **Howard E. McKinney** was promoted to manager of the newly-created Engineering department of Shell Development's Exploration and Production Research Laboratory. He joined the research staff in 1943 and has been a senior engineer since 1950.

•

Sunray Mid-Continent Oil Company engineers who received recent promotions are **Frank C. Folger, Jr.,** named chief unitization and proration engineer; **Tom P. Harris,** named chief waterflood engineer; **Walter N. Kellogg,** new chief reservoir engineer and **G. Dudley Strother, Jr.,** appointed chief development engineer. Folger joined Sunray in 1951 and has held various engineering posts in the Production department since that time. Harris joined the company in 1927 as gasoline plant chemist. He was superintendent of secondary recovery from 1943-55 for Mid-Continent Petroleum Corporation, since merged into Sunray Mid-Continent. Kellogg joined Sunray Mid-Continent in 1950 and has been engaged in reservoir unitization and development work. Strother joined the company in 1947 as junior engineer in the Oklahoma City production district. He was Kansas division engineer in 1948-49, South Texas district engineer from 1950-52 and has been a senior engineer in the Production department's general offices since 1953.

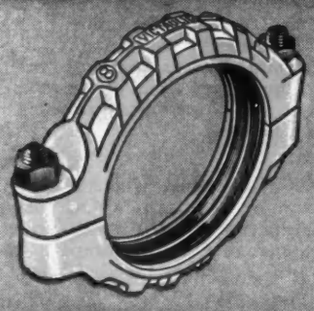
•

Clyde M. Keithly has terminated his partnership with Pinkston, Miller and Keithley and has opened offices at 427 Perry-Brooks building, Austin, Texas, as a petroleum engineering consultant specializing in Railroad Commission hearings, oil and gas property appraisals and unitization.

•

Harry D. Gasarch's appointment as assistant comptroller of **Socony Mobil Oil Company, Inc.** recently was announced. He has been manager of Socony Mobil's comptroller's foreign department since 1953, on assignments in Western Europe, West Africa and the Middle East. Gasarch joined the company in 1929 as a junior clerk in domestic trade and, in 1951, became manager of accounting and statistics reviews.

VICTAULIC METHOD OF PIPING



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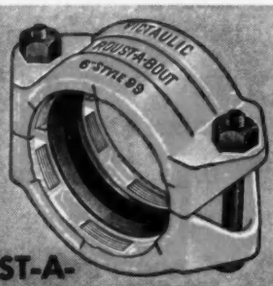

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(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

George T. Briggs

Harry X Bay

Robert H. Martin

Kilburn E. Adams

George T. Briggs, promoted from division manager, Louisiana division, to assistant general manager, Producing department of **The Texas Company,** will be located in the general manager's office at Houston. **Harry X Bay,** assistant division manager in Louisiana, will succeed Briggs as division manager. Briggs' service with Texaco started in 1927 at Houston as a clerk. In 1929 he was transferred to the Louisiana division, being appointed division manager in 1954. Bay entered the service of the company in 1936 as a geologist in the Louisiana division; in 1951 he was made assistant division manager. Promotion of **Robert H. Martin** to division geologist, Rocky Mountain division, also has been announced by The Texas Company's Producing department. Martin joined the company as a geologist in 1942; in 1954 he was advanced to senior geologist, general manager's staff at Houston, his former position. Replacing him is **Kilburn E. Adams, Jr.,** who transferred from Tulsa. He joined Texaco in 1933 as a clerk in the Boston division office, Sales department. He has been assistant division geologist in the Oklahoma division for the past three years.

•

C. Elton Gore, promoted to regional geologist in the central region of **Lion Oil Company's** Production and Exploration division, formerly was district geologist in the Wichita, Kansas, district. Gore joined the company in 1952 as a geologist in Wichita. In 1954 he was promoted to district geologist.

•

Dr. J. A. Culbertson, who has been named manager of **Continental Oil Company's** Exploration department, was formerly assistant manager of exploration. He will continue to make his headquarters in Houston. Culbertson joined Conoco in 1933 and served four years in the geophysical division at Ponca City before transferring to Houston in 1937 as assistant division geologist. In 1951 he was promoted to assistant manager of the exploration department.

Honolulu Oil Corporation announces the transfer of **Jack van Wyke** to its Calgary office as petroleum engineer for that division. van Wyke, with Honolulu 20 years in its California operations, has recently been located at the company's Taft office where he was in charge of field petroleum engineering.

•

Kenneth Martin, recently appointed chief accountant of the **Skiles Oil Corporation,** will be located at their main office in Mt. Carmel, Ill. Martin has had extensive petroleum accounting experience with the Haskill accounting firm and as former office manager for M. E. Affeld, Chicago independent oil operator.

•

Hugo R. Kamb, long active in Southwestern oil and gas exploration, has been appointed senior geologist on the staff of the **Delhi-Taylor Oil Corporation.** In this capacity, he will review and evaluate geological proposals submitted to the company. For the past ten years, Kamb has been division geologist and exploration coordinator for the Crown Central Petroleum Company in Houston.

•

J. H. (Jake) Flesher, district superintendent of **The Bell Oil & Gas Company,** one of the oldest regular employes of any oil company, retired at the age of 75 October 1. He joined the Bell organization as a driller in the Panhandle field in October, 1929. During the several years following, he was drilling superintendent of leases in the Panhandle and then became district superintendent, which position he has since held.

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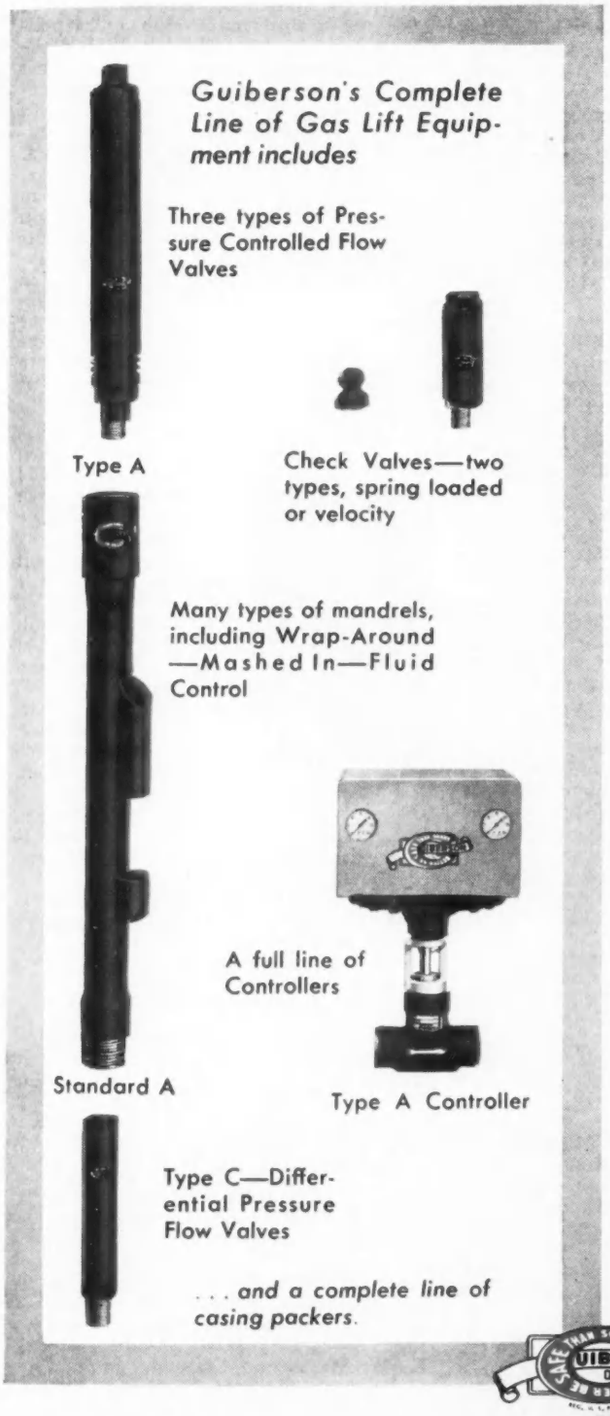
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E. E. (Wimpy) Moore, formerly of Trident Drilling Company, has formed his own company, **The Moore Drilling Company, Ltd.**, with offices in the Petroleum building, Calgary, Alberta. Widely-known throughout the oil industry, Moore was with the Arrow Drilling Company many years before forming Trident Drilling Company in Calgary which he served as vice president and manager. He resigned from Trident to form this company which now has three rigs in operation in Alberta and Manitoba.

E. E. Moore

•

William E. McKitrick, Shell Oil Company senior geologist who recently returned from Calgary to assume a new administrative position in Los Angeles, will be responsible for the coordination of organization procedures and technical personnel. McKitrick started with Shell as an assistant geologist in 1938.

•

Kin-Ark Oil Company has added two geologists to its field staff. **Byron Andrews** will be stationed at company headquarters in El Dorado, Ark., and **Richard Herscher** will work in the branch office in Denver. Andrews was employed as a geologist by the Lion Oil Company and later as a consultant in the oil fields of West Texas. In his new position he will be employed in sub-surface work as well as in drilling operations in several of the Mid-Continent projects being developed by Kin-Ark. Herscher, formerly a geologist in various Colorado fields, will do geological survey work for Kin-Ark on oil properties leased by the company in the Denver-Julesburg region.

•

Mikton Oil Company announces the election of **David L. Garrison** and **John T. Lochridge** to its board of directors. Garrison is president of Bel Oil Corporation in Lake Charles, La., and Lochridge is vice president, Fifteen Oil Company, Houston.

•

M. L. Slusser, a member of **Magnolia Petroleum Company's** Field Research Laboratories technical staff since 1949, has been promoted to senior research chemical engineer. He has been assigned problems of formation damage and production stimulation in the Drilling Mechanics and Well Completion group of the Production division.

•

Ed. G. Wheeler, formerly purchasing agent for Blaw-Knox Company, has joined the **Ralph M. Parsons Company**, Los Angeles construction engineers.

•

H. R. (Ross) Bolton will be elected vice president in charge of exploration and production of **Crescent Corporation** to succeed **C. A. Houy**, who has resigned to become president of the **Lee Evans Drilling Company of Tulsa.** Bolton joined Crescent in 1950 as chief engineer and has been manager of production. Houy joined Crescent in 1950 as general superintendent of production. He will direct the exploration and production activities at Lee Evans.

J. P. Jones, assistant manager-consumer of **Standard Oil Company's** Wichita, Kansas, division, retired October 1 after more than 39 years of service. **R. V. Ware**, assistant manager-reseller in Standard's Joliet, Ill., division since 1954, has been named to succeed him. **K. J. Hollett**, assistant manager for the LaCrosse, Wis., division since 1946, was transferred to the Joilet position. Jones joined Standard in 1915 in the Wichita division; rising through clerical positions, he became sales manager in 1922. After a few months at Standard's Chicago general office in 1937, he was advanced to assistant manager at Wichita. Ware started with the company in 1941 as a salesman. In 1949 he was promoted to sales manager at Detroit, Mich., and in 1952 returned to the general office as sales manager-reseller. Hollett began as a service station attendant at Decatur, Ill., in 1923. He was named sales manager-consumer for Decatur in 1937. In 1940 he was transferred to Indianapolis in the same position. The following year he moved to the general office as sales manager-reseller.

•

Dr. James Edward White has been appointed supervisor of the physics section of **The Ohio Oil Company's** Research Center, now under construction. Other research department heads at the center are: geology section, **Dr. R. Dana Russell;** chemistry section, **Dr. Louis C. Gibbons;** and engineering section, **Dr. Fred H. Poettmann. W. H. Barlow**, manager of research for Ohio Oil, is located at the General Office in Findlay, Ohio. White was director of the M.I.T. Underwater Sound laboratory in 1944 and 1945 and worked for the Defense Research Laboratory at the University of Texas in 1946. From 1949 to 1955 he was in charge of geophysics research at the Field Research Laboratories of Magnolia Petroleum Company.

Dr. J. E. White

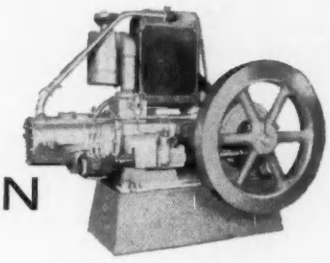
•

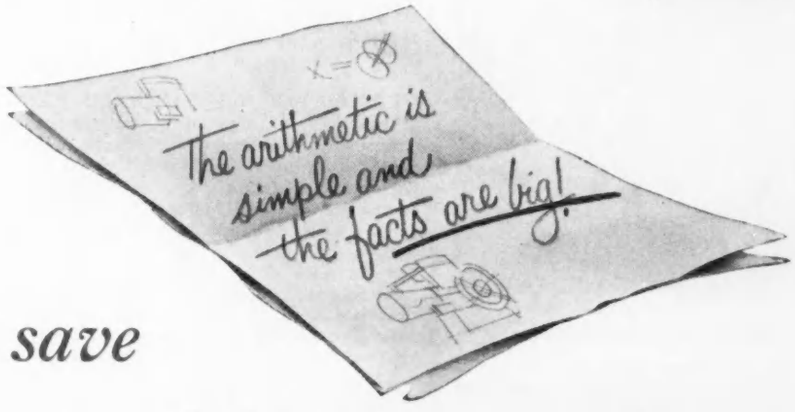
Russell Maguire has opened a geological office in the Mellie Esperson building in Houson to cover the Gulf Coast area of Texas and Louisiana. **James A. Quigley**, formerly with The Texas Company, has been named manager of the new office.

•

Shell Oil Company has announced that **R. N. Duncan**, of the Transportation and Supplies department, will be responsible nationwide for all products supply, crude and volatiles, and transportation and supplies economics activities. His title will be changed from manager, transportation and supplies—New York to supplies manager. **K. W. Martin**, now manager of transportation and supplies for Shell Oil Company of Canada, will become transportation manager of Shell Oil Company and will be responsible for nationwide marine transportation, products pipe line and traffic activities. Duncan, who joined Shell in 1927 as a clerk in the Manufacturing department, was named assistant manager of supplies in 1941 after holding various positions in the Midwest. Martin joined Shell of Canada at Vancouver in 1932 and since that time has served in various capacities in Canada including division operations manager; manager of Shell Canadian tankers and manager of transportation and supplies department.

Mr. MANAGEMENT MAN





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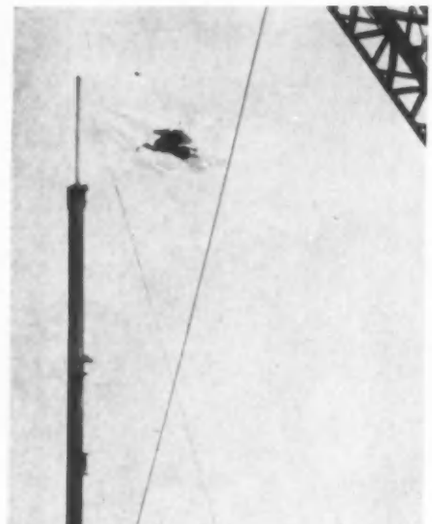
Companies in the News



Flies Above Manhattan

The Flying Red Horse house flag of Socony Mobil Oil Company flies 45 stories above mid-Manhattan on the steel skeleton of the company's new national headquarters. The block-square building when completed in 1956 will be the world's largest stainless steel sky-scraper and its sixth largest office building.

•

COLORADO OIL AND GAS CORPORATION has announced formation of a wholly-owned subsidiary to conduct operations in Canada. Headquarters of the new corporation, Colorado Oil and Gas Ltd., will be in Calgary, Alberta. The entire staff of Trafford & Associates Ltd., petroleum consulting firm of Calgary, has been employed by the new company. **E. Trafford**, formerly president of the consulting firm, has been named vice president and general manager of Colorado Oil and Gas Ltd.; he has also been elected a vice president of the parent company. Other executive personnel of the new company include **R. Pot**, chief reservoir engineer, **J. B. Newland**, geologist, and **K. R. Stout**, production superintendent, all members of Trafford & Associates. In addition to his Canadian responsibilities, Pot will act as consultant to the parent company on reservoir engineering problems. Among properties which Colorado Oil and Gas Ltd. will operate initially are oil and gas wells in the Pembina, Joffre and Tofield-Beaver Hill Lake areas transferred from the parent company. Continued development of these properties and an intensified exploration program are scheduled during the year.

•

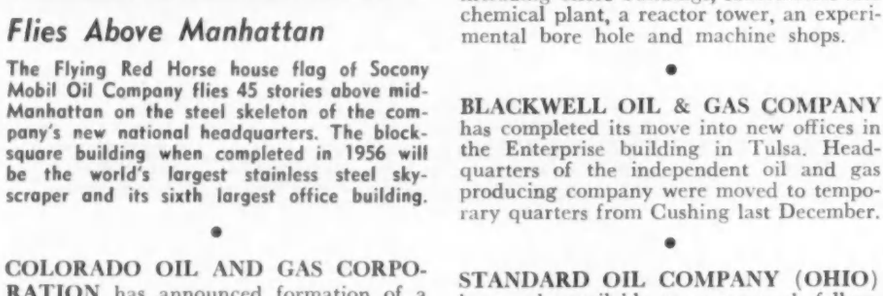
STANOLIND OIL AND GAS COMPANY has donated land, buildings and equipment of its former research laboratories in Tulsa to the University of Tulsa. The gift, valued in excess of $950,000, is one of the largest ever made to the university. The 23-acre site, which will be known as Tulsa University's North Campus, includes 29 brick and metal buildings, including office buildings, laboratories and chemical plant, a reactor tower, an experimental bore hole and machine shops.

•

BLACKWELL OIL & GAS COMPANY has completed its move into new offices in the Enterprise building in Tulsa. Headquarters of the independent oil and gas producing company were moved to temporary quarters from Cushing last December.

•

STANDARD OIL COMPANY (OHIO) has made available seven research fellowships and a grant-in-aid, totaling $18,000, to seven universities for the 1955-56 school year. Participating in the Sohio fellowship program are Western Reserve University, Case Institute of Technology, Ohio State University, University of Illinois, Cornell University, University of Michigan and University of Chicago.



Conoco Transforms Oil Storage Tank

Completion by Continental Oil Company of a $500,000 research pilot plant built at Ponca City, Okla., around an unused oil storage tank has been announced. The dismantled and reassembled 80,000 barrel tank, faced with aluminum and porcelain enamel, has a spacious, circular open interior area, approximately 60 feet in diameter which serves as the pilot area. Surrounding this area are three floors of laboratories, offices, high-pressure cells, and utility and conference rooms, all built on the curve, which provide a total of 33,000 square feet of floor space for some 60 Conoco scientists and technicians.

REITER-FOSTER OIL CORPORATION has acquired Quick Oil Corporation, Cardinal Drilling Corporation, Empire National Drilling Company and Five Star Drilling Company, all of Tulsa, through an exchange of stock. Reiter-Foster's operations office will be moved from New York to Tulsa as a part of the company's reorganization program and extension of operations. Field offices are located in Cushing and Oklahoma City.

•

THE TENNESSEE GAS TRANSMISSION COMPANY has begun more extensive oil and gas production operations in the Rocky Mountain region of the U. S. and Western Canada, creating a Rocky Mountain Production division. The new division and intensified activity in the two areas began with the purchase of Far West Oil Company operations in Wyoming, and the recent acquisition of oil and gas properties formerly owned by Bay Petroleum Corporation and the personal producing properties of C. U. Bay, former president of Bay Petroleum. Much of the newly-acquired property is in the Rocky Mountain region and in the Province of Alberta, Canada. Headquarters for the new division have been set up in Denver, with production district offices in Casper, Wyo.; Chase, Kansas; Oklahoma City and Edmonton, Canada. **H. I. Craig**, a veteran of 36 years in the oil business and an employe of Bay Petroleum since 1940, heads the division as division production superintendent. Others in the office include **H. E. Rowe, Jr.**, division engineer, also a former employe of Bay Petroleum, and **Sam F. Willson, Jr.**, division production clerk, who has been with Tennessee Gas a number of years. District production superintendents, all formerly with Bay Petroleum are: Casper, **Patterson Lay;** Chase, **Glen E. Armour;** Edmonton, **J. A. Leask**, and Oklahoma City, **J. D. Hicks.**

•

BUFFALO OIL COMPANY recently established a department of purchasing, warehousing and transportation. **Joe A. Huitt**, prominent in the purchasing field throughout the Southwest and middlewest, will head the new department, joining Buffalo after 26 years with Deep Rock Oil Corporation.

•

THE TEXAS COMPANY and **SOCONY MOBIL OIL COMPANY** grants have helped establish the first academic center for the study of fossil spores and pollen in the Western Hemisphere. To be at New York University, the center was designed to train graduate students in the technique, application and solution of problems in petroleum geology through the analysis of spores and pollen. The American Museum of Natural History's Department of Micropaleontology will provide the laboratory and classroom space. A total of $4000 was given by the two oil companies to cover cost of laboratory equipment. Instrumental in establishing the new program were Walter S. Olson, supervising geologist of the Foreign Producing department of Texaco, and Eugene Jablonski, coordinator of exploration at Socony Mobil.

DEATHS

Alfred E. Fowks, 88, pioneer California oil man who helped bring in the famed Lakeview gusher, died August 27 in Los Angeles. Fowks was field superintendent for Union Oil Company in the Midway-Sunset field when the famous gusher came in out of control in March, 1910. He came to California in 1908 after working in oil fields in Pennsylvania and northern Peru. He retired over 20 years ago as assistant manager of production for Union Oil Company.

F. E. (Swede) Swenson, 50, president, State of Texas Exploration Company, died in Gunnison September 16. He was manager of the Land department, Deep Rock Oil Corporation, when he resigned about six years ago to accept the position in Texas.

E. B. Stewart, 60, veteran oilman and manager of the Ohio Oil Company's Tulsa division, died September 10. He had been with Ohio since 1919, and had been manager at Tulsa since 1954.

Floyd A. Young, 79, independent oil operator, died September 9 in Hiawatha, Kansas. He had been active in early oil development in northeastern Oklahoma.

Elmer H. Jones, 60, pioneer California oil well supply man, died September 4 in Palos Verdes. Jones, since 1931, had headed his own company, Pacific Southwest Pipe Company. He had been engaged in the oil well supply business in California since 1915.

Paul H. Ivey, 50, oil writer and formerly a field superintendent for Standard Oil Company in South America, died September 20.

James Clarence Virdell, 55, co-owner of the Virdell Drilling Company, Llano, Texas, died September 4 at Waco.

Harry A. McGill, 76, pioneer Oklahoma oil operator, died September 13.

R. W. Simpson, 76, died September 3 at Ada, Okla. He was an Oklahoma oil operator and banker and a long-time resident of Ada.

Luther C. Gaines, 67, died in San Antonio August 30. A pioneer in the Texas oil fields, he operated a trucking firm in Mexia for several years. At the time of his death, Gaines and his son operated the Gaines Drilling Company in Corpus Christi.

Doyle Johnston, 43, died in Russell, Kansas, from injuries suffered in an automobile accident. He was superintendent with Morris Sitrin Oil Producers in Hays, Kansas.

Joseph E. Elliott, 53, general commercial manager for Southwestern Gas and Electric Company, died recently in Shreveport. He played an important part in applying electric power to the various phases of the petroleum industry in the East Texas oil fields, and was a charter member and a past president of the Petroleum Electric Power Association.

George Skakel, 63, founder and board chairman of the Great Lakes Carbon Company, his wife and two others were killed October 3 when their private plane crashed 20 miles west of Oklahoma City.

Marshall H. Massey, 60, widely-known industrial engineer, died October 4. For 25 years he held executive positions with the Waite Phillips Company and the Independent Oil and Gas Company, and as manager of procedure department for Stanolind Oil and Gas Company.

Louzetta Eliza Hanthorn, 67, well-known to Mid-Continent oil circles, died October 6. She was secretary and office manager for the O.R. Howard Oil Company 35 years.

Fred Guy Sarber, 70, independent oil operator and general superintendent of the Burke-Greis Oil Company, died in Wewoka, Okla., September 1. He had been with the Greis oil firm since 1913.

Isaac McKinley Gearhart, 94, pioneer oilman, died recently in Tulsa. Entering the oil business in Pennsylvania near the turn of the century, he had lived in Tulsa since 1918 and remained active as an independent oil broker from 1920 until six months ago. He was in the land department of The Texas Company almost 20 years before becoming an independent broker.

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What's Happening

AMONG INDUSTRY ASSOCIATIONS

Officers of the American Association of Oilwell Drilling Contractors for 1955-56 installed at the fifteenth annual meeting in Houston are, seated, left to right, D. B. Ferguson, Ferguson Drilling Company, vice president for cable tools; H. W. Davidson, Davidson Drilling Company, national vice president; M. M. Brantly, Brantly Drilling Company, vice president for New Mexico and West Texas; Dale Mount, Harry Bass Drilling Company, president; Brad Mills, A.A.O.D.C., executive vice president; W. C. Fatjo, W. C Fatjo Drilling Company, vice president well servicing. Standing, left to right, Earle C. Hellums, Gracey-Hellums Corporation, vice president for Gulf Coast; Ray A. Sing, Big Horn Drilling Company, vice president for Rocky Mountains; Jack H. Abernathy, Big Chief Drilling Company, vice president for Central-Mid-Continent; W. L. McClusky, M. J. Delaney Company, secretary-treasurer; and George H. Pappas, Paco Petroleum Corporation, vice president for Illinois, Michigan, Indiana and Kentucky.

Dale Mount Elected New AAODC President

E. Dale Mount, vice president and general manager of the Harry Bass Drilling Company, was elected president of the American Association of Oilwell Drilling Contractors at the fifteenth annual meeting in Houston.

Mount, who has been long active in AAODC affairs, was graduated from Phillips University at Enid, Okla., in 1928 with an A.B. degree in History of Political Science. He taught school until 1931 when he moved to Tyler, Texas, to join the firm of Champlin & Bass, which later became the Harry Bass Drilling Company.

He started with the company as a timekeeper and progressed to toolpusher, drilling superintendent and then to his present assignment as vice president and general manager.

Dale has been a director of AAODC for many years and is known for his participation as chairman of the Insurance Committee, national vice president (1953-54) and past chairman of the Fort Worth-Dallas Chapter.

Geological Society Officers Named for North Texas

The newly-elected officers of the North Texas Geological Society with headquarters in Wichita Falls, are Robert T. Drake, North Texas Sample Log Service, president; James M. Harmon, W. M. Summers & Associates, vice president; O. W. (Buzz) Fauntleroy, R. Clay Underwood, secretary; and Charles R. Haworth, Superior Oil Company, treasurer.

Houston Nomads Host International Visitors

Attending a recent Nomads meeting in Houston were, front row, left to right, R. F. Gollum, Socony Mobile Oil Company, Inc., New York Nomad; Dan D. Childers, Socony-Vacuum Oil Company, Inc., Caracas; and Kent Charles, British Petroleum Company, Ltd., Calgary, Alberta. Back row, left to right, are J. T. Durbin, Stanolind Oil & Gas Company, Houston; Jacques Brijac, CFP (A), Algiers; and Jim Means, Stanolind, Houston.

Three Industry Associations Win Safety Council Awards

Of 11 associations cited by the National Safety Council for outstanding work in preventing occupational accidents during 1954, three represented the oil industry. They are the American Association of Oilwell Drilling Contractors, American Gas Association and the Society of Exploration Geophysicists.

They received the Safety Council's Association Award last month at the 43rd National Safety Congress and Exposition in Chicago.

The award recognizes general excellence of association safety services, particularly for their contribution to the reduction of work injuries in small firms.

Desk and Derrick Names 1956 National Officers

Edna Hurry of New York City was elected president of the Association of Desk and Derrick Clubs of North America for 1956 at the closing session of the Fourth Annual Convention in September.

Hurry, who is with Standard Oil Company (N. J.) as office manager, Public Relations department, served as first vice president during 1955. She succeeds Sybil Sureck of Oklahoma City as president.

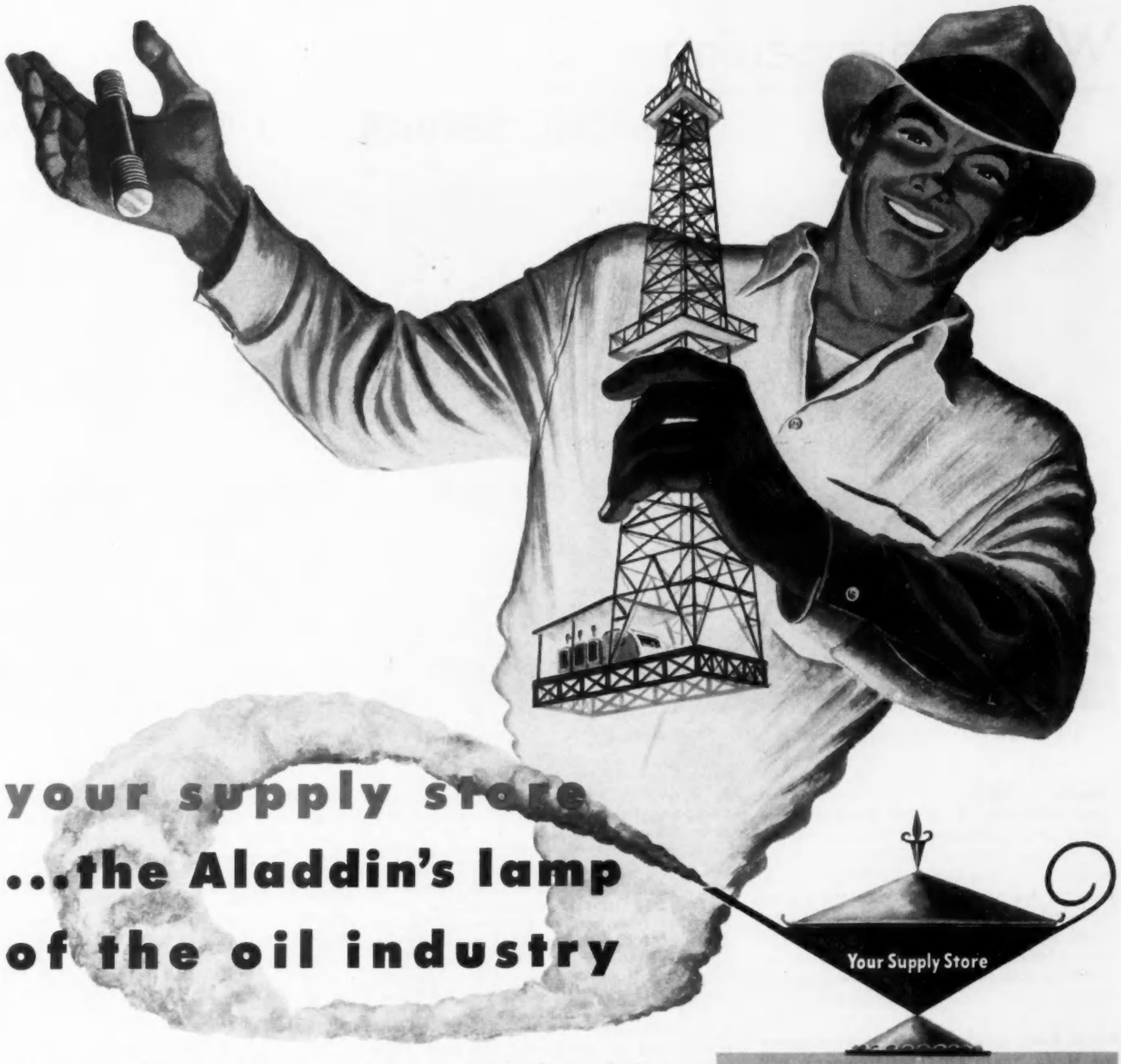
Other officers elected were: Lydia Babka, Honolulu Oil Corporation, first vice president; Irma Cline, Nelson, Montgomery, Robertson and Sellers, second vice president; Elizabeth Van Kuyk, Socony Mobil Oil Company, secretary; and Esther Welch, Pioneer Natural Gas Company, treasurer.

New regional directors are Edith Snizek, Rand McNally & Company, Region I; Harriet Gregath, Tide Water Associated Oil Company, Region II; Ellen Vaughan, Carter Oil Company, Region III; Margaret Sevier, Taylor Oil and Gas Company, Region IV.

LaVerne Montgomery, Rocket Petroleum Company, is director of Region V; Anita Lang, Phillips Petroleum Company, Region VI; Edda Eldredge, Utah Southern Oil Company, Region VII; and Zetta Belle Housley, Shell Chemical Company, Region VIII.

Penn State Schedules Conference on Production

Seventeen papers have been listed tentatively on the 3-day program of the Nineteenth Technical Conference on Petroleum Production scheduled by the Department of Petroleum and Natural Gas Engineering of Pennsylvania State University in cooperation with the Pennsylvania Grade Crude Oil Association. To run November 16-18 at University Park, Penn., the sessions will include papers on petroleum displacement by detergent solutions, study of fluid flow in synthetic porous media, comparisons of air permeability and water input profiles and unsteady-state behavior of linear gas storage reservoirs.



your supply store ...the Aladdin's lamp of the oil industry

Your supply man might not look too much like a genie, but nevertheless he . . . and an army just like him . . . is at your beck and call 24 hours a day, ready to serve you with the latest and the best in oil field equipment. And he is backed up with the technical knowledge and the services of the reputable manufacturers he represents.

He has earned the support you can give him by purchasing all of your requirements . . . "Through Your Supply Store."

LARKIN
...Through Your Supply Store

From a stud bolt to a drilling rig, your supply store serves all your needs promptly

PESA
PARTNERS IN PETROLEUM PROGRESS

We've moved — Our new address is:
LARKIN PACKER COMPANY, INC.
WAXAHACHIE, TEXAS
W A X — A — H A C H I E
(rhymes with walks) (rhymes with scratchy)

What's Happening

AMONG SERVICE AND SUPPLY MEN

Charles A. Bryant

Cleve Holt

George L. Abbott

Robert M. Waples

E. J. Dower

R. R. Rector

J. I. Thomas

Paul Kittrell

T. C. McDonald

J. I. Norton

Lloyd A. Davis

W. R. Singletary

Charles A. Bryant has been named advertising manager of **Baroid Division**, National Lead Company. He has served for the last five years as assistant advertising manager of Mid-Continent Supply Company. Prior to that, he was advertising manager of the Dallas World and advertising production manager of The Wall Street Journal. He was also assistant advertising manager of Butler Brothers in Dallas.

Cleve Holt, as new district sales engineer for **H. C. Smith Oil Tool Company**, will maintain headquarters in Houston and will service East Texas and Louisiana. He was for several years field engineer for Security Engineering Company in Texas and Oklahoma.

George L. Abbott, president of **The Garlock Packing Company** since 1928 and with the company since 1911, was elected chairman of the board and chief executive officer recently by the board of directors. He is succeeded by **Robert M. Waples** who moved up from the executive vice presidency which he has held since 1952. Waples previously was branch office clerk, sales representative, assistant to the manager, service department manager and a vice president. Elected to a vice presidency was **William M. Sheffeld**, who has been assistant to the president since 1952.

Warren Automatic Tool Company announces that **E. J. Dower** has joined its staff as director of research and development. Dower formerly was senior research engineer at Southwest Research Institute where he specialized in mechanical engineering and instrumentation with particular reference to the oil drilling industry.

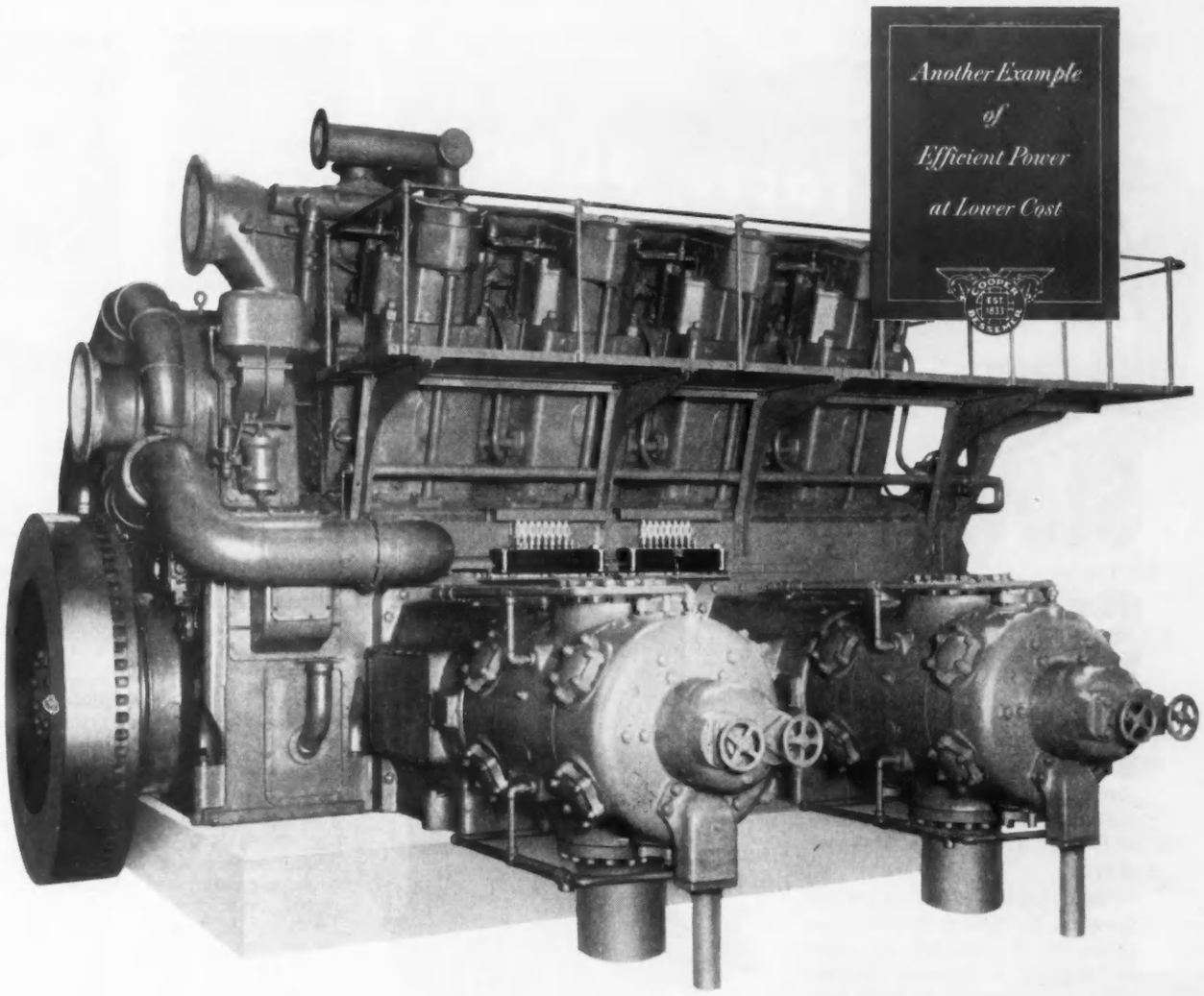
R. R. Rector, of **Rector Well Equipment Company, Inc.**, who started two years ago as a sales representative in West Texas, has been transferred to Great Bend, Kansas, as district representative. **J. I. Thomas**, who has been in the oil business since 1936 for oil and supply companies, has been appointed manager of the Corpus Christi district for Rector. In other appointments recently announced by the company, **Paul Kittrell**, with three years experience with supply and drilling company, has been named sales representative at Abilene; **T. C. McDonald**, who spent 12 years with service and oil companies and four years as sales representative for Rector, has been transferred to Shreveport; and **J. I. Norton**, after six years with service and supply companies, was named to represent Rector in Lafayette, La. **Lloyd A. Davis** is new sales representative in Oklahoma City after spending eight years with supply companies; and **W. R. Singletary** represents Rector products and services in Houston. He served eight years with various drilling, service and equipment companies.

BrakeSol, Inc., recently announced the following changes in personnel: **Jim Page**, former sales manager in the Odessa, Texas, area, has been transferred to Casper, Wyo., to serve the territory of Wyoming, Montana and the Dakotas; **Buford Cranford**, who formerly worked out of Casper, has been transferred to the home office in Oklahoma City as supervisor of sales engineers; and **M. F. (Frenchie) Howard**, who recently joined the BrakeSol organization, will serve as sales engineer working out of Lovington, N. M. **Lester Brake**, president of the company, has just returned from a tour of the oil fields in Venezuela where BrakeSol is setting up distribution through the National Supply stores.

W. (Ham) Redford has been appointed division sales engineer at the Midland, Texas, sales office by **Lane-Wells Company.** Prior to his appointment, Redford was in operations and sales in the North Central Texas and Arklatex areas. In the Shreveport office, **E. V. Cleveland** has been appointed district sales engineer for Arklatex district. He joined Lane-Wells in 1952 in the same area as a perforating operator in Arkansas and northern Louisiana. Prior to his appointment, he was in charge of the Vivian, La., truck station.

Sargent Engineering Corporation, in dividing its Mid-Continent operations, transferred **O. H. Leichliter** to Fort Worth. He will be in charge of the company's operations in the Southern division which consists of field stores in Odessa, Snyder, Houston, Sundown, Wichita Falls and Quitman, Texas; Magnolia, Ark.; and Hobbs, N. M. **V. A. Kelley** will direct operations in the Northern division which includes Seminole and Pawhuska, Okla.; Chase and Russell, Kansas; and Grayville, Ill.

A. P. Brown, formerly sales engineer at Odessa for **The Western Company**, has been promoted to senior sales engineer. **Don Hammack**, formerly sales engineer at Cushing, Okla., has been transferred to Odessa in the same capacity. **Tom Bergin**, senior sales engineer at Hobbs, N. M., has been moved to Lindsay, Okla.; **Bill Shaw**, sales engineer at Lindsay, has been transferred to Healdton, Okla.; and **Wallace McBrayer** is now sales engineer at Hobbs. Employed by Western four years, McBrayer previously was sales engineer at Liberal, Kansas, and district operating manager at Ulysses, Kansas.



Soon to go "on line"...
GMWA's for Pacific Northwest Pipeline

As the year's largest pipeline project, the 1,466-mile Pacific Northwest Pipeline is "Big News" throughout the industry.

Still another news item is the economy and performance story of Cooper-Bessemer GMWA compressors. Before very long, 13 of these 1500 hp units will be "on line" in four of Pacific Northwest's modern compressor stations.

These GMWA gas engines will deliver *lower cost* compressor horsepower because they produce *more power* per square foot of floor space, with a resulting reduction in housing and foundationing expense. In addition, each is equipped with high clearance cylinders for greater flexibility over a wide range of suction and discharge pressures.

Even though GMWA's boast a high ratio of horsepower to space, there's the same accessibility, sturdiness and long-life operating dependability that has been associated with the Cooper-Bessemer name for more than a century. Contact the nearest office listed below . . . find out how you can save money, increase efficiency with Cooper-Bessemer V-angle compressors.

MOUNT VERNON, OHIO

COOPER-BESSEMER

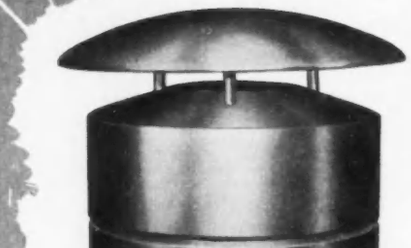
GROVE CITY, PENNA.

New York City • Seattle, Wash. • Bradford, Pa. • Chicago, Ill. Houston, Dallas, Greggton, Pampa and Odessa, Texas Washington, D. C. • Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. • Gloucester, Mass. • New Orleans, La. • Tulsa, Okla. • Cooper-Bessemer of Canada Ltd., Edmonton, Alberta—Halifax, Nova Scotia.

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS

COLD facts about a HOT subject . . .

Stewart Stoves



● Decide right now to replace make-shift heating facilities this winter with clean, safe, dependable Stewart Stoves.

Equipped with regular Stewart Hi-Efficiency B-4 gas burners—"The Burner without an equal"—Stewart Stoves provide plenty of heat at low cost, for derrick floors, warehouses, supply stores, garages, industrial plants, etc.

They are furnished for use with either natural, butane, propane or manufactured gas—furnished with or without vents.

Natural gas stoves furnished with gas valves, pilot light and pressure regulator. Butane stoves do not have pilot light and pressure regulator.

CONSTRUCTION: Bodies are heavy sheet steel. Rounded top, baffle plates and legs are cast iron. Finished with high temperature aluminum paint.

TWO SIZES:

Model 15: 50,000 BTU, 35" high by 19" O.D. Wt. 100 lbs.

Model 20: 150,000 BTU, 48" high by 24" O.D. Wt. 200 lbs.

When ordering, specify gas to be used.

PESA — Petroleum Equipment Suppliers Association — Partners in Petroleum Progress

WELL EQUIPMENT MFG. CORP.

HOUSTON, TEXAS

fmc — Food Machinery and Chemical Corporation

Division of CHIKSAN COMPANY *a subsidiary of* FOOD MACHINERY AND CHEMICAL CORPORATION

WECO ®

Roscoe G. Ayers

R. E. Batchelor

W. K. Harwood

John R. Suman

The Bovaird Supply Company has announced the following promotions of executives: **Roscoe G. Ayers** has been advanced to vice president and general manager; and **Raymond E. Batchelor** has been advanced to vice president and sales manager. Ayers and Batchelor are both directors of the company and each has had 30 years or more experience in the manufacturing and distribution of petroleum equipment and supplies. **W. K. Harwood**, petroleum engineer, has become associated with the company to serve in an advisory capacity to staff and management. He formerly was with the Harwood Oil Company. In the Sales department and Stores division, **William J. Bovaird** has been advanced to general manager of stores, supervising stores operations in Oklahoma, Kansas, Illinois, Texas and New Mexico. Joining the company in 1948, he has been assistant to general manager of stores for three years. **Thomas C. McCuistion** has been advanced to assistant to sales manager. He has had 20 years' experience with Bovaird.

John R. Suman, former vice president and director of Standard Oil Company (N. J.), has been elected a director of **Schlumberger Well Surveying Corporation.** Suman retired from Standard Oil in March, 1955. He opened an office in Houston as consultant, and effective July 1, 1955, he was retained by Chemical Corn Exchange Bank and Blyth & Company, Inc., of New York in a consulting capacity. He also was elected to the Advisory Committee of the board of directors of the Chemical Corn Exchange Bank. Having served in various executive capacities with Rio Bravo Oil Company, East Coast Oil Company of Mexico and Associated Oil Company of California, Suman was a director of Humble Oil from 1927 to 1933. In 1945 he was elected vice president and director of Standard of New Jersey and became a regular member of the executive committee in 1946.

Alan Wood Steel Company recently announced the appointment of **John L. Hallman** as manager of the Marketing division. Philadelphia district sales manager since 1951, he joined Alan Wood in 1939.

Robert F. Cashen

Jack P. Pouland

Earl N. Stone

A. R. Brown

Robert F. Cashen has been appointed manager of the Petroleum department of **The First National Bank** in Shreveport. A petroleum engineer, Cashen was with Stanolind Oil & Gas Company seven years in engineering development and production and valuation and reserve work.

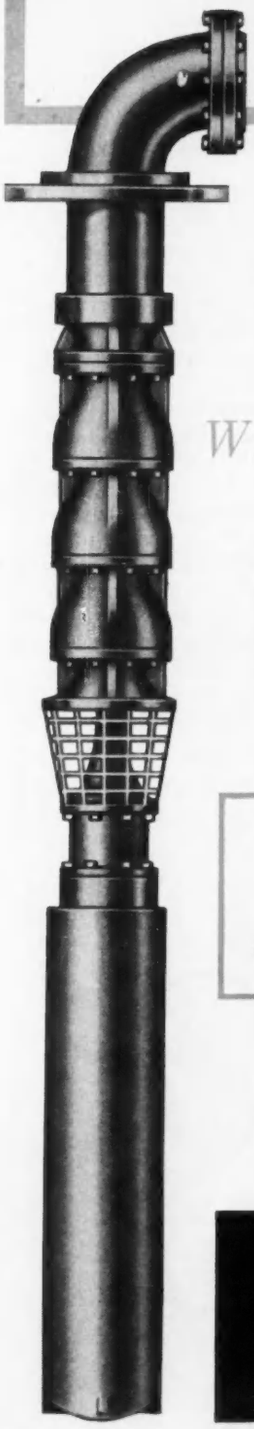
Jack P. Pouland, a veteran of more than eight years in oil well servicing work, has been named sales representative for **Welex Jet Services, Inc.,** in Kansas. With the company five years, Pouland formerly was district manager of the Great Bend, Kansas, office. **Herman D. Foster, Jr.,** has been named sales engineer for Welex in the Wichita Falls district; **Roy H. Cossey** has been appointed sales engineer at Shawnee, Okla., and **Ernest M. Elbert** has been transferred as sales engineer to the San Angelo, Texas, district. **Edward B. David** has been appointed district manager of the new Welex office in Farmington, N. M. A veteran of over 10 years in oil well service work, he has been field supply man, rigman, shooter and logging engineer.

Earl N. Stone has been appointed sales engineer for Colorado, Utah, western Kansas, Montana and Wyoming, as well as the Farmington, N. M., area for **Edward Valves, Inc.,** subsidiary of Rockwell Manufacturing Company. In his new position, Stone will introduce the Rockwell-built Edward Mudwonder valve for oil drilling mudlines to the Rocky Mountain area. He also will handle the complete Edward line of cast and forged steel valves. Stone previously was employed as sales engineer for Orbit Valve Company.

United Supply and Manufacturing Company announces the appointment of **A. R. Brown** as district manager for the firm, supervising four stores in West Texas and three in New Mexico. Brown joined United Supply in 1944 as a floor man at Oklahoma City. He was assistant district manager in the Ardmore, Okla., area before his recent appointment.

Verti-Line *Submersible*

BOOSTER PUMPS



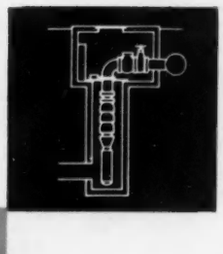
Layne & Bowler's half-a-century of experience in the design, engineering and manufacturing of vertical pumps, and the know-how of General Electric in the electric motor field *are now joined to produce the most advanced Submersible Booster Pumps made.* Sizes from 5 to 125 H.P.

Why Submersible Boosters?

For invisible, noiseless operation!
For safety – to people and equipment!
For dependability in any weather!
For maximum use of minimum space!
For maintenance-free performance, without adjustment or lubrication!

Some typical applications

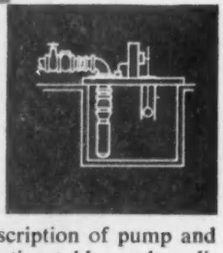
pumping directly into distribution mains



fire protection

sump operation

cooling tower service



Send today for new bulletin containing description of pump and motor features, material specifications, selection tables and application data. Ask for bulletin R-115

Verti-Line Pumps are the exclusive products of
LAYNE & BOWLER PUMP COMPANY
general offices and main plant
2943 VAIL AVENUE • LOS ANGELES 22, CALIFORNIA

(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

STAY ON BOTTOM LONGER WITH THE RIGHT EQUIPMENT

Round trip time is not only non-productive—it also adds to the wear and tear of your rig and to your cost per foot of making hole.

Round trips cannot be eliminated but they can be reduced. Actual cases throughout the country show that diamond drilling bits stay on bottom longer, drill a straighter hole and require less weight.

You can save time and money by using one of the many varieties of Christensen Diamond Drilling Bits, manufactured in any size and designed to fit your particular drilling conditions.

Take advantage of a Christensen Diamond Drilling Bit by (1) outright purchase—you pay for the diamonds in the bit plus a setting charge. Upon return of the used bit you are credited with diamonds salvaged; (2) rental basis—you gain the advantages of a diamond drilling bit at a predetermined price per foot, and have the added advantage of knowing bit cost per foot well in advance of the drilling operation.

CHRISTENSEN DIAMOND PRODUCTS

LESS COST PER FOOT CHRISTENSEN DIAMOND PRODUCTS

1937 SOUTH 2nd WEST SALT LAKE CITY, UTAH

H. M. Shearin

J. R. Thrasher

M. O. Duncan

Don S. Rawlings

Core Laboratories, Inc. recently announced the addition of **H. M. Shearin** as senior petroleum engineer in the reservoir engineering and consulting department. Prior to his new appointment, Shearin was with Humble Oil & Refining Company, Gravity Meter Exploration Company and U. S. Engineers.

J. R. (Jim) Thrasher, who has been named sales representative in north Louisiana for **Well Equipment Manufacturing Corporation,** will make his headquarters in Shreveport. He has had four years experience with Gulf Oil Company, in the Warehousing and Purchasing department, was sales and service representative for Reed Roller Bit Company, and, more recently, represented National Tank Company.

M. O. Duncan has been appointed sales representative for the Ardmore, Okla. area of **Harbison-Fischer Manufacturing Company.** Before joining the firm, Duncan was with Jarecki Manufacturing Company, Mid-Tex Supply Company and Jones Equipment Company.

Don S. Rawlings, Jr., has recently joined the engineering staff of **Howe-Baker Corporation,** Houston. First with Neches Butane Products Company as process engineer, Rawlings resigned to become petrochemicals editor of PETROLEUM REFINER.

Gifford V. Leece, president of **Gardner-Denver Company,** has been elected chairman of the executive committee to succeed **Ralph G. Gardner,** who recently retired as treasurer and head of the executive committee. Gardner continues as chairman of the board of directors and as a member of the executive committee. **Alexander G. Lindquist,** vice president and formerly secretary and comptroller, has been named treasurer and a member of the executive committee. At the same time, **Charles M. George,** assistant to the president, was elected secretary of the company, and **William H. Miller** was named assistant treasurer.

Charles R. Williams

M. C. Hightower

Davis L. Key

James R. Stevens

Charles R. Williams, appointed sales manager of the **Union Tank and Supply Company,** will direct company-wide sales activities. In addition, he will continue as regional manager of the West Texas-New Mexico operation of the company. Williams has been with Union Tank and Supply nine years, and has held positions as sales representative and branch manager in the Alice, Texas, area and as regional manager in Dallas. **Marion C. Hightower,** formerly branch manager for Black, Sivalls & Bryson, Inc., has been appointed sales representative for Union Tank and Supply at Oklahoma City; **Davis L. Key** has been appointed sales representative at Kilgore, Texas; and **James R. Stevens** has opened a new city sales office for the company at Cushing, Okla. Stevens was formerly a sales engineer with Diamond Oil Well Drilling Company. Key was with Baker Oil Tools before joining Union Tank and Supply.

Cochrane Corporation recently announced the appointment of **M. C. McKeown** as manager of the Philadelphia district sales office. He has been technical director of the Water Treating division of Cochrane and manager of technical training.

Dresser Industries' Security Engineering plant at Whittier, Calif., has named **Hammond Helms** new manager. Prior to joining Security, Helmes was with Cameron Iron Works in Houston. **D. R. Fulton** is the newly-appointed Detroit district manager for Roots-Connersville Blower Division, also one of the Dresser Industries. Fulton was transferred from Chicago where he has represented Roots since 1949. At Ideco, **Ed. C. Kirby** has been appointed technical service representative. He will have headquarters in Houston.

Chiksan Export Company has appointed **Earl Fuller** representative for Indonesia and South Asia. With headquarters in Bandung, Java, he will cover Indonesia, British Borneo, Pakistan, India, Assam and Burma, handling the entire line of Chiksan and Weco products. Fuller has a long background of petroleum drilling and production experience throughout Asia. Since 1951 he has maintained headquarters in Java.

RIDGID
2-S
Every RIDGID Pipe Tool TESTED individually before shipment
Extra Fast...
...easy...pipe reaming with this self-feeding
RIDGID
Spiral . . . turns into the work smoothly, no chatter. Famous RIDGID heat-treated cutting edges mean clean reaming, extra long service. Quick enlarging of conduit box outlets—and holes in sheet metal. More for your money—buy the 2-S at your Supply House.
for power and hand reaming . . .
RIDGID
LonGrip
5 long straight flutes ream clean, easy to control.
RIDGID
Work-Saver Pipe Tools

The Ridge Tool Company • Elyria, Ohio • U.S.A.

(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

Lee Watts Appointed Director Of New Pacific Pumps Office

Pacific Pumps, Inc., Huntington Park, Calif., announces the opening of their San Francisco office for centrifugal pump sales. The office will be under the direction of Lee Watts, who has been with Pacific's Los Angeles district office.

Magcobar Announces Opening Of New Houston Sales Office

Magnet Cove Barium Corporation has opened a city sales office in the Houston Club building. W. C. (Red) Rye, division sales manager for the company's Texas-Gulf Coast division, and James C. Hewitt, sales representative, will work out of the new office.

Fluor Corporation Forms Pipe Manufacturing Firm

Formation of the Prairie Pipe Company, Ltd., of Regina, Saskatchewan, to manufacture steel pipe for the oil and gas industries has been announced by D. W. Darnell, chairman of the board of the Fluor Corporation, Ltd., and president of the new firm.

Operating as an affiliate of the Fluor Corporation, the new company's $3.5 million plant will be located on a 110-acre site outside Regina. Construction has been started by Fluor Corporation of Canada who will build the plant.

J. E. Cunningham, former district engineer for Fluor in Houston, has been named vice president and general manager. He will be located at Regina.

Capacity of the new plant will be more than 100,000 tons a year. The company will manufacture pipe from 4½ to and including 16 inches, conforming to API specifications.

Sail for Europe

Frank Lebus, Jr., and Mrs. Lebus recently sailed for Europe aboard the U.S.S. United States. While touring France, Germany, Holland and England, Lebus will set up distributorships for Lebus products.

Borg-Warner Research Center Is Now Under Construction

Plans for the construction in Des Plaines, Ill., of a multi-million dollar Borg-Warner Research Center have been announced. Construction of the first unit has been started on a 36½-acre site at the corner of Algonquin and Wolf Roads.

The new laboratory will contain facilities for metallurgical, electronic, electrical, chemical, acoustical, hydraulic, applied mechanical, physics and nuclear research. The laboratory also will house a complete machine and model shop, a modern computation center and a large technical reference library. Building is expected to be completed next Spring.

Mid-Continent Opens First Nebraska Store

Mid-Continent Supply Company's newest store, and its first in Nebraska, recently was opened in Kimball. Inset is the store manager at the new location, B. K. Manor, who has been with Mid-Continent eight years.

Sperry-Sun Adds Two Cessnas In Rocky Mountain, Coast Areas

Sperry-Sun Well Surveying Company, Houston, has added two new Cessna 180's to expedite reaching rig locations in the Rocky Mountain and Gulf Coast areas. The Gulf Coast plane is equipped with floats. Pilots for this faster service are Wayne Lotspeich, based at Casper, Wyo., and Grady Bell, who hangers in New Orleans. Both men are trained and equipped to operate and service all Sperry-Sun instruments.

Gardner-Denver Establishes Engineering Scholarships

The board of directors of the Gardner-Denver Company has announced the establishment of an engineering scholarship fund that is part of the Gardner-Denver foundation. Up to the present, scholarships have been granted to technical fields, including scholarships to mechanical, mining and petroleum engineers.

Scholarship grants are given to schools which are leaders in their specific fields. Student selection is made by the schools on the basis of their requirements jointly agreed to by the Gardner-Denver Company and the schools involved.

Two graduate fellowships have been awarded, one in mining engineering and one in mechanical engineering. There have been three undergraduate petroleum engineering scholarships awarded, one undergraduate mining engineering scholarship and five undergraduate scholarships in the field of mechanical engineering. So far, a total of 11 scholarships or fellowships have been given in nine colleges.

Stewart & Stevenson Is New Greer Distributor

Stewart & Stevenson Distributing Company, has been named national distributor, exclusive of California, for Greer mud pump pulse dampers and drill rig blowout preventers. California will be serviced by the Greer West Coast office.

Headquartered in Houston, Stewart & Stevenson Distributing Company has offices at all oil producing fields in the continental U. S. The company will provide both sales and service and will stock parts for Greer's line of drill rig hydraulic accessories, including a patented line of blowout preventers and mud pump pulse dampers. Robert M. Hardy is general manager.

Drill rig operators in the California oil fields will be provided with sales and service facilities at the Greer office in North Hollywood, Calif. Oil field sales activities there will be headed up by Zachary LeBolt.

Phillips to Manage New Store Opened By Bovaird in Oklahoma

As a part of their expansion program, Bovaird Supply Company opened a new store at Pawhuska, Okla., October 3. J. C. Phillips is store manager under F. J. Robbins, district manager at Oklahoma City. Phillips, who has been with Bovaird since 1950, has been servicing the territory out of Sapulpa as a salesman the past two years. He was formerly located at Seminole.

The Pawhuska store is fully stocked with complete line of drilling and production equipment and supplies. It will serve the Osage, Burbank areas and the southeastern Kansas and northeastern Oklahoma territory.

AVAILABLE JOHNSTON by AL CAPP

WHO IS YO', AN' WHAR IS YO' GOIN'?
AH IS AVAILABLE, AN' HE IS ACCURATE JOHNSTON—AN' WE IS GOIN' T' TEST A OIL WELL!!
SMACK OUT HERE, IN TH' OCEAN?
YAS'M!!—US JOHNSTONS TEST OIL WELLS, ANY-WHAR, ANY TIME—AN' FAST!!
COME BACK!! TELL ME MORE!!
CAIN'T, MA'M!!—WHEN WE GO OUT T' TEST A WELL, WE CUTS LOST DOWN-TIME TO A MINNY-MUM!!

C-548

Copr. Capp Enterprises 1954

JOHNSTON TESTERS

first in drill stem testing

HOUSTON, TEXAS

LOS ANGELES, CALIF. • CALGARY, CAN.

FORMATION AND CASING TESTING — JOHNSTON

Davey, Paxman Oil Industry Headquarters Moved to London

Headquarters for the Oil Field activities department of Davey, Paxman & Co., Ltd., are being transferred from Colchester to the company's London offices at No. 1 Balfour Place, Mount Street, London W. 1. W. K. Burley, in charge of world-wide oil field sales of Paxman engines, will henceforth be located in the London office.

Torrington Promotes Eight And Creates New Divisions

Promotion of eight executives of the sales organization and formation of new divisions have been announced by The Torrington Company. Promoted were: Donald E. Lewis, to sales manager, Bearings division, at Torrington; Raymond G. O'Connell, to assistant sales manager, Bearings division; Richard A. Ramsey, to manager of Torrington's Detroit office; Clarence H. Rowe, to sales manager, Needle division; C. Raymond Johnson, to assistant sales manager, Needle division; and Wesley B. Meeteer, to manager, Torrington Needle office, Chicago.

Because of the growth of the individual divisions of the Specialty Sales department and the complexity of its products, the department has been split into three new divisions, Swaging Machines, Surgical Needles and Specialties (precision metal parts.)

Robert A. Clarke has been appointed sales manager of Swaging Machines and Surgical Needles divisions. Richard S. Keppelman has been appointed sales manager of the Specialties division.

Made for each other —— for a HAPPY COMBINATION
McKISSICK
Block-Hook
COMBINATION
Heavy steel construction throughout . . . no need to add ballast for extra weight.
Center or divider plates between each sheave to distribute load more evenly, prevent deflection.
Readily adaptable to all popular hooks. Combinations are easily separable.
Shown is Block with BYRON-JACKSON COMBINATION.
McKISSICK
McKISSICK PRODUCTS CORPORATION
Box 2496 Tulsa, Oklahoma

John W. Brown

James E. Hughes

Brown Fintube, Western Supply Sign Representation Agreement

E. D. Anderson

A new agreement of representation and collaboration in the heat exchanger industry has been announced by John W. Brown, Jr., president of Brown Fintube Company, and James E. Hughes, vice president of Western Supply Company. Under the agreement, Western will become sales representatives for Brown in Kansas, Oklahoma and the urban and rural areas of Kansas City, Mo.

Under the affiliation, Brown will be provided with experienced representation for their heat transfer line, including the sectional hairpin finned tube exchanger. Also, certain areas of utilization of Brown fintubes in shell-and-tube exchangers will be made possible. Brown has been developing their finned surface for a variety of applications, while Western has been active in employing finned surface to shell-and-tube use.

E. D. Anderson, Western's chief engineer since 1947, will be especially active in the second phase of this representation because of earlier work at Brown Fintube Company in development of heat transfer data on the basic Brown longitudinal finned surface.

Thompson Heads New Office Of Gulf Publishing Company

Gulf Publishing Company of Houston announces the opening of a North Texas district office. Ed Thompson has been appointed district manager and will office at Room 518, Second Unit, Santa Fe building, Dallas.

Ed Thompson

Thompson has had extensive experience in the advertising selling field, formerly being employed by the Texas Harte-Hanks Newspapers. Before that he was connected with the Abilene Reporter-News.

Gulf publishes five specialized oil industry publications—PETROLEUM REFINER, THE REFINERY CATALOG, WORLD OIL, PIPE LINE INDUSTRY and THE COMPOSITE CATALOG. Thompson will concentrate most of his efforts on the last named three publications, but will be available for consultation also on problems concerning refining industry advertising and cataloging.

Lane-Wells Announces Changes, New Facilities in Texas

To better serve Texas customers, Lane-Wells has moved into a new building in Beaumont, where J. T. Dolan is sub-district superintendent. In McCamey, new facilities have been established on Highway 51 North. L. I. Bates has been named station superintendent.

Fred Plumlee, formerly station superintendent at Cisco, Texas, has been transferred to Odessa as district sales engineer; John R. Ross, station superintendent at Sweetwater, has been transferred to Cisco; and V. R. McWhirter, radioactivity operator at Gainesville, has been appointed to replace Ross.

Taylor Instrument Companies Occupies New West Coast Plant

Taylor Instrument Companies' San Francisco offices and plant recently have been moved across San Francisco Bay to San Leandro, Calif. The new plant is capable of duplicating many manufacturing and repair techniques followed in the company's main plant in Rochester, New York.

Set up to make repairs and assemble new instruments, it contains 16,800 square feet of floor space, a substantial gain over former quarters.

Republic Supply Is Completing New Store In Shreveport

The Republic Supply Company is completing a new store building in Shreveport which will contain the warehouse, store display room and store and district offices. The pipe yard will adjoin the store location.

A. L. August is district manager of the area, which includes north Louisiana, Arkansas and the East Texas field. K. W. Curry is administrative assistant to the district manager, and Homer T. Hopkins, a veteran of 32 years' service with Republic Supply, is store manager.

New GSI Middle East Division To Be Headed by Stoutjesdyk

Formation of a Middle East division of GSI, Dallas-based geophysical contracting firm, has been announced. Peter S. Stoutjesdyk will be manager of the division, with headquarters in Cairo, Egypt.

The division will operate within the company organization of Geophysical Service International, S.A., an Eastern Hemisphere affiliate of the Dallas firm.

Stoutjesdyk, formerly a GSI field supervisor, gained extensive seismic experience with the Shell interests in Borneo and Sumatra. He was working in Tunisia when he joined GSI in 1953.

American Iron & Machine Works Executive Returns from Europe

C. L. Griffin, sales manager for the American Iron and Machine Works Company, Inc., has returned from an extended tour of Europe where he assisted the Dalmine Steel Mill of Dalmine, Italy, in the engineering, tooling and manufacturing procedures of the American Iron straight grip pipe threads which they have been licensed to turn. He also contacted oil country tubular goods and oil tool manufacturers in Italy, Germany, Holland, France and England.

WORLD OIL'S Trading Post CLASSIFIED ADVERTISING

RATES: Regular Classified (undisplayed) set in this size type: 12 cents per word. Minimum charge, $3. Blind box address in our care counts six words. Replies forwarded without charge. Situation wanted ads, 6 cents per word. Display ads, set in suitably larger type with ruled border, $12 per column inch; situation wanted display ads, $6 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. All classified ads payable in advance. COPY DEADLINE: 17th of month preceding date of issue. Send copy and checks to: Trading Post Section, World Oil, P. O. Box 2608, Houston, Texas.

FOR SALE

IDEAL RANCH

IN THE HILL COUNTRY EAST OF LEAKEY

3840 acres, more or less, 100 in cultivation. Ideal for raising high-grade cattle, sheep, goats. Plenty of turkey and deer. Beautiful home with all modern conveniences. Write "Ranch," P. O. Box 2608, Houston 1, Texas, for complete details and pictures.

FOR SALE: Premises of Dunlap & Graham at 2450 Cerritos Avenue, Long Beach, California. Ideal for Drilling Contractor, Oil Well Supply Yard, Etc. Price $35,000.00, or might consider long term lease.

FOR SALE: 7" O.D. x 24' Gammaloy Drill Collar. Brand New. Never Been Run. Cost $4930.00. Take $4500.00. Dunlap & Graham, 2450 Cerritos Ave., Long Beach, California. Phone 43961.

■ GEOPHYSICIST: A major contracting geophysical company has an opening for a geophysicist to be in charge of its foreign department. Must have 10 years experience, the majority in foreign service, a college education, and an ambition to make new acquaintances. Write details of age, education, experience, availability for travel, etc., to Box 75-W, World Oil, Houston, Texas. Our employees know of this ad.

■ FOR SALE: Two Rotary Tables for Model 250 Joy Drill, hydraulic pull down, automatic chuck. Used three months—cost $6000.00 each. Sell for $3500.00 each. J. N. Pitcher Co., 6825 Mission Street, Daly City 25, California.

■ CABLE TOOLS FOR SALE. Good condition. Wichita 61, Fort Worth Super "D." Both Rigs with masts, motors, light plants, dog house, etc. Good iron from 15"-5½". W. H. McGarr Industries, P. O. Box 826, Coleman, Texas.

BUSINESS SERVICE

■ Delaware Corporations formed and serviced. Inquire without obligation. American Guaranty & Trust Company, 910 West Street, Wilmington, Delaware.

NEWLY ORGANIZED DALLAS INDEPENDENT OIL COMPANY DESIRES TO PURCHASE PRODUCTION AND WILL INSPECT MERITORIOUS PROPERTIES SUBMITTED IMMEDIATELY. BOX 74-W, WORLD OIL, HOUSTON, TEXAS.

BUSINESS OPPORTUNITIES

Well organized, well established oilwell drilling contractor desires the management and supervision of oil properties in West Texas, Central Texas, and New Mexico. Can provide complete handling of oil properties, from acquisition to production. No properties too small, and none too large to handle. Inquiries from independents, groups, small or medium sized oil companies invited. Write, wire, or call collect for further information.

MAKIN DRILLING COMPANY

P. O. Box 1628, Hobbs, New Mexico, Phone 3-3141
146 Allen Building, Midland, Texas, Phone 2-2962

MISCELLANEOUS

CUBAN OIL

Our organization can obtain oil concessions, farmouts, join in the financing of oil developments, handle all Government, corporate, legal, fiscal, banking, accounting, labor, and all local matters relating to the oil industry.

Solicit our report on oil possibilities in Cuba

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CASTINGS!

JUST CALL YEL-O-WELD
REG U S PATENT OFFICE
AMERICA'S NO. 1 PROCESS

3 TIMES STRONGER than the ORIGINAL Cast Iron

All Work Unconditionally Guaranteed

A special process that produces a GUARANTEED weld, without pre-heating or heat distortion!

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INCREASE PRODUCTION
CLEAN OUT CHOKING SAND

Excessive sand and sediment holds back your oil. For fast, easy clean out with fewer round trips and less down-time, use world famous Miller Sand Pumps.

SAND PUMP SIZES
O.D.—2½, 3, 3½, 4¼, 5, 5½, 7 In.
Lengths—20, 25, 30 ft.

Composite Catalog, Page 3433

Write for descriptive price list.

MILLER SAND PUMPS

Miller Sand Pump Co.
General Offices, Box 4516
Oklahoma City 9, Okla.

EXPORT OFFICES
30 Rockefeller Plaza
NEW YORK CITY 20, N. Y.

Three-Part Harmony

A woman who wanted to sing in grand opera asked a German music professor to give her an audition. He played her accompaniment and listened to her for a few minutes, but she sang so badly off key that he finally slammed down the piano lid and refused to continue.

"What's the matter?" asked the woman in amazement. "Don't you like my singing?"

"Der trouble mit your singing, madam," said the exasperated professor, "is dot vedder I play on der vite keys or on der black vuns, you sing all the time in der cracks!"

Adaptable

The sour-faced, oddly dressed lady was poking among the brooms in the hardware store when a clerk asked if he could help her.

"Nothing here is worth buying," she snapped. "Flimsy, cheap straw, poor handle, shoddy material!" Seizing the last broom in the stock, she shook it under the nose of the bewildered clerk and said angrily: "Not like the brooms they used to make! Give the floor one good sweep and it would fall apart! What's it good for?"

"Well," the clerk said after a thoughtful pause, "you may find that it flies wonderfully."

Realist

Child specialist to mother of small boy: "You'll have to handle this child carefully. Remember, you're dealing with a sensitive, high-strung little sinker."

WORLD OIL

"Wish I could look at the oil business as openly as you do."

Pro Services

Sandy joined a golf club, and was told by the professional that if his name was on his golf balls and they were lost, they would be returned to him when found.

"Good," said the Scot. "Put my name on this ball." The pro did so.

"Would you also put M.D. after it?" asked the new member. "I'm a doctor." The pro obeyed.

"Now just one more thing," went on the Scot. "Can ye squeeze 'Hours 10 to 3' on as well?"

KEEP PURE DRINKING WATER ALWAYS HANDY

insist on the highest quality

Gotkool
water cans and coolers

Specify "GOTKOOL" the next time you order water cans or coolers. "GOTKOOL'S" exclusive construction keeps water cooler . . . fresher . . . purer. Extra wide, snug-fitting, splash-proof top keeps out impurities. Non-leaking, push-button faucets, either extended or recessed flush mounted. *Buy "GOTKOOL" at your supply store today.*

GOTKOOL Water Cooler — made in 2, 3, 5, 8, 10, 15, and 20-gallon sizes with extended or recessed flush-mounted faucet optional. *(Note: 15- and 20-gallon sizes available with extended faucet only.)*

GOTKOOL Water Can — made in 1½, 2, 3, 5, 10, and 20-gallon sizes without faucets. Extended or recessed flush-mounted faucets available at slight additional cost. *(Note: 15- and 20-gallon sizes available with extended faucet only.)*

Insist on the genuine — look for the *Blue and Black Label* with the name "GOTKOOL" in Red.

H. P. GOTT MFG. COMPANY
WINFIELD, KANSAS

Over
50
Locations in the United States and Canada

McCullough® REPORTS TO THE OIL INDUSTRY

Service
Anywhere Anytime

New Services • • • New Tools • • • New Methods • • • Outstanding Results

Combination Magna-Tector and String Shot Back-Off Recovers 3431′ of Crooked Pipe in One Run

While McCullough's "One Trip Back-Off Service" is not yet available in every branch area, the many branches equipped to render this valuable service report the successful completion of some difficult back-off operations.

In this instance 3431′ of crooked drill pipe was recovered in one run in the hole. However, of greatest value to the operator was the fact that the Magna-Tector indicated that pipe could not be recovered from the lowest free point.

Operator was drilling below 3600′ with 4½" O.D. drill pipe and 6" O.D. drill collars when pipe became stuck. While attempting to free the pipe, the string parted about 100′ below the surface and dropped to bottom causing it to become corkscrewed and crooked.

After taking hold of the fish, McCullough's Magna-Tector was worked down the pipe and established a definite free point at 3609′ at the top of the drill collars. However, after double checking, it was found that torque could not be applied to the crooked drill pipe below 3440′. Therefore, the String Shot Back-Off was fired at the first collar that would back-off at 3431′. Only one shot was required and the free pipe was recovered from that point. The successful completion of this difficult operation required only one trip in the hole and saved the operator considerable time and money.

Check with your nearest McCullough service location about McCullough's "One Trip Back-Off Service." It is available in an increasing number of areas.

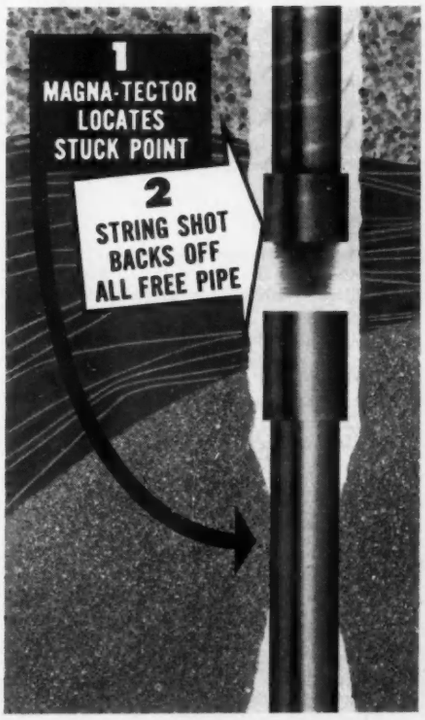
Magna-Tector, String Shot Back-Off Recover Stuck Pipe from 12,200′

High Efficiency and Small O. D. of McCullough's Magna-Tector and String Shot Back-Off Permit Recovery of Full String of 2⅞" Drill Pipe

Substantial rig time and fishing expense were saved by McCullough's Magna-Tector (Free Point Finder) and String Shot Back-Off in recovering this string of small diameter drill pipe.

The operator was running in the hole with 2⅞" drill pipe and was only 90′ off bottom when the drill pipe parted 200′ below the surface, dropping the entire string.

McCullough Tool Company ran in with a socket and took hold of the parted pipe. Following this, a String Shot Back-Off was run which backed off the pipe two joints below the socket.



McCullough Magna-Tector and String Shot Back-Off locate the lowest point from which pipe may be recovered and loosen all free pipe in a matter of hours compared to the days needed by mechanical methods.

And, the "One Trip Back-Off Service" will save an additional 50% in rig time in the areas in which it is available.

Socket was removed and operator ran back in and screwed into the fish. After working the pipe a short time it again parted, this time at about 300′.

Again, a socket was used to catch the fish and the McCullough Magna-Tector was worked down to two joints above the drill collars at a depth of 12,200′ where it found the pipe to be free. It was necessary to pull maximum strain on the 2⅞" drill pipe to straighten out the crooks so the Magna-Tector would go down.

A String Shot Back-Off was fired at 12,200′ and the pipe was recovered from that point.

Both the McCullough Magna-Tector and String Shot Back-Off are long, thin tools. Their small diameters permit them to operate through any tool or pipe that has as little as a 2" fluid passage. In this instance these tools were worked through approximately 12,000′ of 2.026" I. D. drill pipe which had been bent and kinked by a 90′ drop.

Two Bulletins Available

1. No. 401 covers the McCullough Magna-Tector and String Shot Back-Off as individual tools.
2. No. 402 covers McCullough "One Trip Back-Off Service" featuring the great new combination of the Magna-Tector and String Shot Back-Off Tool.

Write to McCullough Tool Company, 5820 South Alameda Street, Los Angeles 58, California.

McCullough® TOOL COMPANY

Cable Address: MACTOOL

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SECONDARY RECOVERY
CABLE ENGINEERING
TECHNICAL CONSULTING
PRODUCTION ENGINEERING
SERVICE, INCLUDING
CORE ANALYSIS

PRESSURE MAINTENANCE WITH GAS OR WATER

WHEN PRODUCTION NEEDS A PUSH...

CALL CABLE

REPRESSURING WITH GAS OR WATER

SURVEYS
ESTIMATES
DESIGN
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SUPERVISION

PETROLEUM ENGINEERS
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WICHITA FALLS, TEXAS

IT CAN'T BE DONE!

but

SAND-BANUM

Pure Colloidal Concentrate

DOES

Remove and Prevent
Boiler Scale and Corrosion
OUNCES ONLY ONCE
A WEEK

•

SAND-BANUM SPECIAL
FOR ALL RADIATOR
COOLING SYSTEMS

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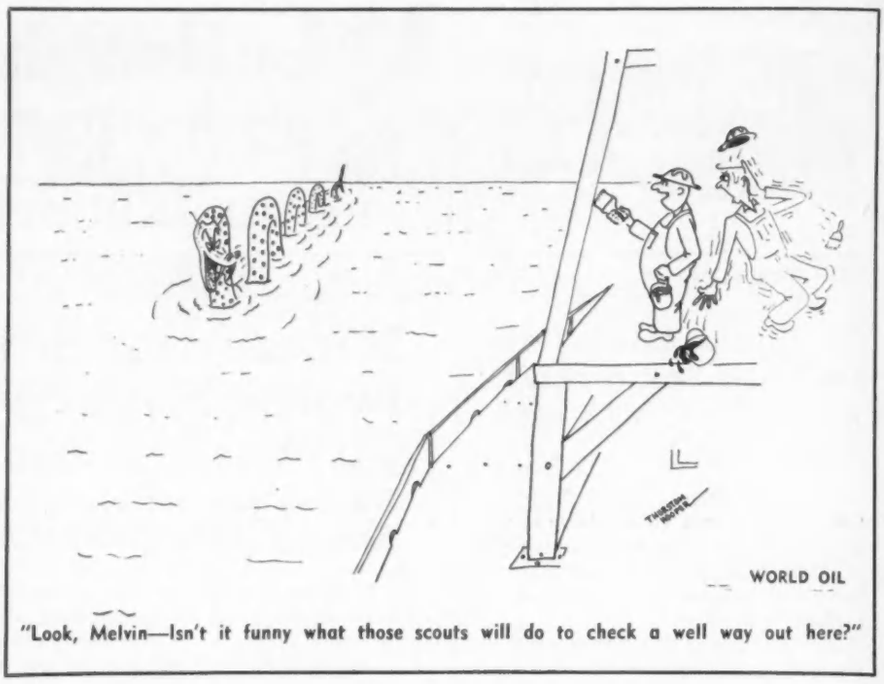

"Look, Melvin—Isn't it funny what those scouts will do to check a well way out here?"

All Business

At the recent meeting of Drilling Contractors in Houston a drilling contractor approached the registration booth and when advised that the registration fee was $20, shoved $17.50 across to the person taking the registrations.

"But the price is $20," she said.

"Well," answered the contractor, "Isn't it customary for drilling contractors to underbid the standing price?"

Budget Style

A woman stopped at the office of an exclusive plastic surgeon. "How much would you charge for altering my nose?" she asked.

"A thousand dollars," the doctor told her.

"Why, that's an outrage!" she exploded. "Isn't there something less expensive?"

"Madam," said the surgeon sweetly as he rose to open the door for her, "you might try walking into a lamp-post."

Order Taker

An officer approached the young man in the neatly-fitting uniform and asked: "What's the eighth general order?"

"I don't know," the fellow admitted.

"Have you ever been on guard duty?"

"Nope."

"You don't even know enough to say 'sir.' What outfit are you in?"

"I'm the soft drink man."

Outdoors Man

Farmer: "Say, you've sure got a lot of nerve to come down in a parachute with this 100-mile-an-hour gale blowing!"

Camper: "I didn't come down in a parachute. I went up in a tent."

Sho 'Nuff

A young boy, going through a cemetery, read this inscription on a tombstone: "Not dead but sleeping." The lad scratched his head a while and remarked to himself: "He sho' ain't foolin' nobody but hisself . . ."

Close Call

Amos (after a narrow escape at a railroad crossing): "How come you blow yo' hawn? You oughta known it wouldn't do you no good."

Sambo: "Boy, dat wa'nt my hawn. Dat was Gabriel's!"

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It Doesn't Cost Anything to Find Out
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Our Sales Engineers are available in all parts of the oil country to show what BRAKESOL will do for your particular Paraffin problem. We do not ask anyone to buy until they have been shown. Just contact your nearest Supply Store to arrange for a FREE field test.

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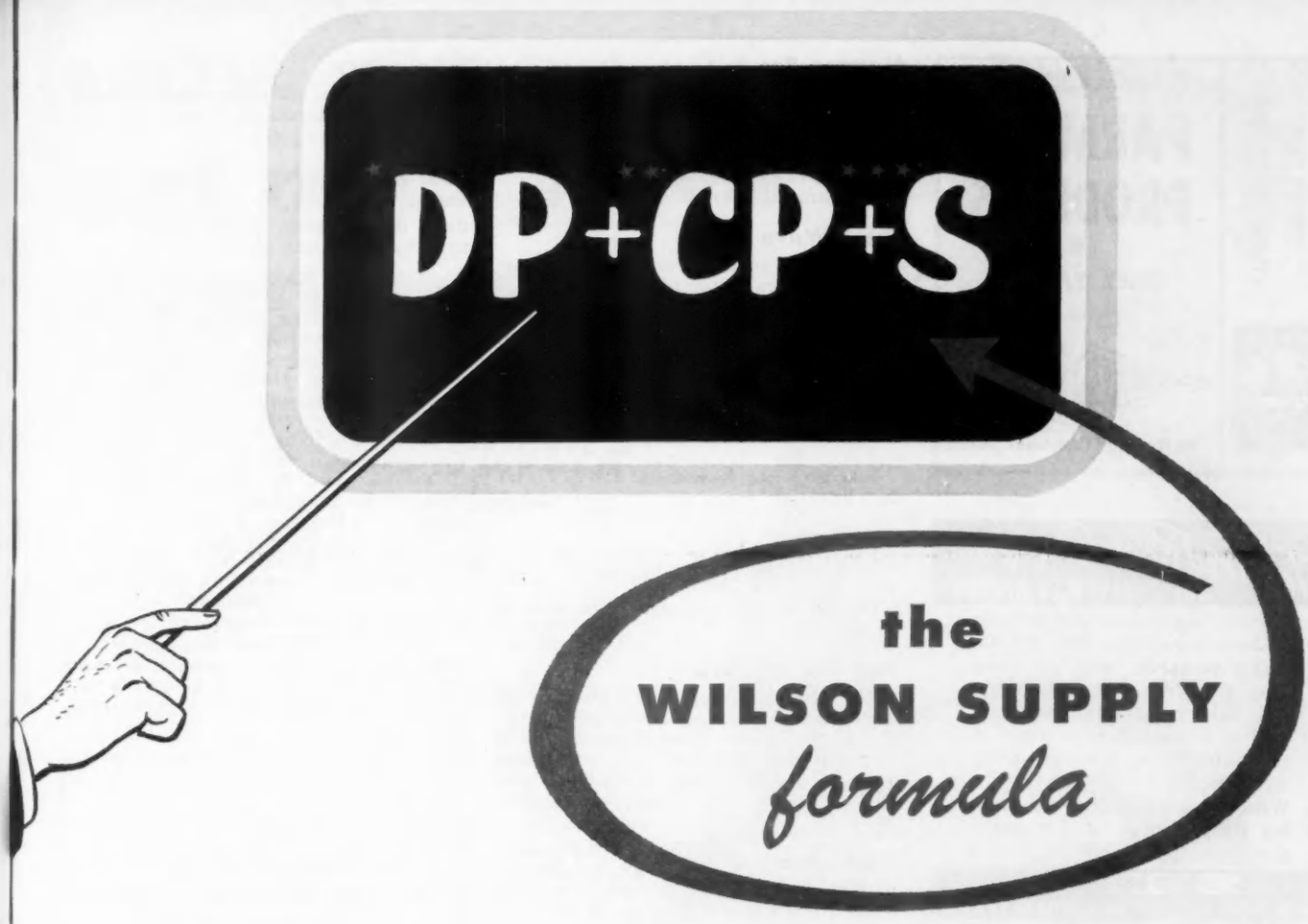

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Every Wilson Supply Company Store is adequately stocked with a complete line of DEPENDABLE products.

★ ★ **COMPETITIVELY PRICED:**

From the hundreds of small items to the largest pump or complete rig—prices are always "COMPETITIVE" at Wilson Supply Company.

★ ★ ★ **SERVICE:**

You get SERVICE at your Wilson Supply Store. Day or night—rain or shine—whether your needs are large or small.

"WHAT YOU WANT — WHEN YOU WANT IT"

MAIN OFFICE and WAREHOUSE—1301 CONTI ST.

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TEXAS: Alice, Corpus Christi, Victoria, McAllen, Bay City, Columbus, Barbers Hill, Liberty, Beaumont, Kilgore, Sherman, Odessa. LOUISIANA: Lake Charles, New Iberia, Houma, Harvey, Shreveport.

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STANDARDIZE ON

PARMACO PRODUCTS

THEY SATISFY

PARKERSBURG MACHINE CO. PARMACO PARKERSBURG, W. VA. U.S.A.

The House of Courteous Service

Texas Red Blush Grapefruit for CHRISTMAS GIVING

The most appreciated gift for your business associates. We are equipped to handle large gift lists. Your grapefruit — holiday wrapped, card enclosed, shipped prepaid — is guaranteed to arrive in perfect condition. Many gift packs to choose from.

Write today for color folder showing complete line of gift packs and prices.

ZEY'S

P. O. BOX 153 MISSION 3, TEXAS

SHIPCO CIRCULATING WHIPSTOCK

Extra length below ring allows greater accuracy in directional settings. Also provides more space for shear pin.

To clean hole of cuttings and cavings—and eliminate extra runs—Shipco Circulating Whipstock is circulated to bottom hole.

G. M. SHIPLEY
SHIPCO CONTROL DRILLING SERVICE
308 McKNIGHT DRIVE
PH. 7-7052 ODESSA, TEXAS

Hydrocarbon
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C B
CARAN BROS. ENGINEERING CO.
Milam Building
San Antonio, Texas
Branch Offices:
Houston and Alice, Texas

Mystery Fan

Author: This is the plot of my story. A midnight scene. Two burglars creep stealthily toward the house. They climb a wall, force open a window and enter the room; the clock strikes one.

She (breathlessly): Which one?

Short Wave

A man was tuning in on the radio when he got a sudden twinge of pain in his back. "I believe I'm getting lumbago!" he exclaimed.

"What's the use," answered his wife, "you won't understand a word they say."

So?

The nurse entered the professor's room and said softly: "It's a boy, sir."

The professor looked up: "Well, what does he want?"

Like Father . . .

Why all of the arguing in the living room?

Grandpa's trying to show Dad how to do my homework.

Just Making Sure

A small boy visiting New York City for the first time went in an elevator to the top of the Empire State Building. As he shot past the 62nd floor at breath-taking speed, he gulped, turned to his father and asked, "Daddy, does God know we're coming?"

Wildcatter

"Whoopee!" cried the drunk as he crashed into the gas station; "I've struck oil."

Country Air

Tourist: "Any famous men born around here?"

Native: "Nope. Best we can do is babies. It's different in the cities, I suppose."

On Second Thought

Two golfers had just finished a round. It was Sunday morning. One spoke up and said, "I suppose we should be in church instead of on the golf course."

"Heck," replied the second golfer, "I couldn't have gone to church anyway. My wife is seriously ill in the hospital."

WORLD OIL

"You mustn't let the fact that you have only one oil well keep you from enjoying the company of other oil men."

Swung Jury

Jury foreman: "We find the defendant gorgeous, breathtaking, sweet, lovable, and—oh, yes, not guilty."

Real Scouts

Elderly lady: Isn't it wonderful how these filling station people know where to set up pumps and get gas?

Forecast

A tourist strolling about a waiting room at a terminal railroad station in Los Angeles was watching a Negro porter as he swept the floor. Deftly but slowly the man made little piles of dirt, cigarette butts and other litter which had accumulated. The morning was warm and clouds were gathering in the sky.

"Sambo," said the tourist, "don't you think there is an excessive amount of humidity in the atmosphere today?"

"Wha's dat?" exclaimed the Negro, wiping the perspiration from his face.

"I was merely extending an interrogation to learn if you thought it was going to rain," said the tourist.

"Well, I nevah!" said the porter. "Does your reckon I would be wastin' my time pushin' dis here broom if I had de perspicacity to prognosticate de precipitation?"

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Phone CApitol 2-1319, Box 132, Houston, Tex.

HOW TO get mud valve economy

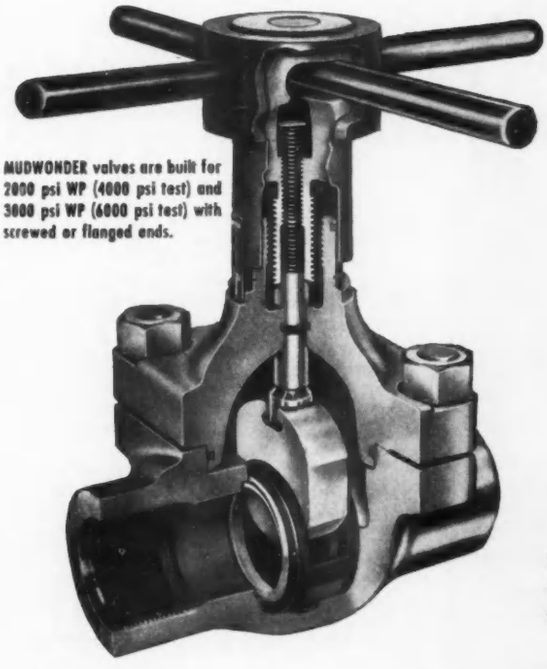
Switch to competitively-priced
Rockwell-Built **MUDWONDER**
Valves for ALL mudline services

Longer wearing parts which can be replaced easily and quickly are causing the big switch to MUDWONDER by cost-conscious drillers.

Whenever maintenance is needed, the operation is simple. Bonnet assembly lifts off without disturbing the mudline hook-up.

Inspection or part replacement, if necessary, can be made while the crew is making a connection. Extra seats and, perhaps, a gate for each size—both are interchangeable between pressure classes—are all the parts inventory you should need.

Replace troublesome mud valves today with MUDWONDER. Drilling men everywhere are switching to MUDWONDER. They've tried it—even abused it—to prove its economical superiority for installation, for operation, for maintenance.



MUDWONDER valves are built for 2000 psi WP (4000 psi test) and 3000 psi WP (6000 psi test) with screwed or flanged ends.

Here is the wear-absorbing heart of the MUDWONDER—
Hard-chromed gate in combination with buna-N seat molded integrally over steel wear rings resist abrasion.

On your rig you can expect the Rockwell-Built MUDWONDER to: SLASH DOWNTIME . . . ASSEMBLE EASILY . . . GIVE LONGER SERVICE . . . OPERATE EASIER, FASTER . . KEEP MUDLINES INTACT . . . STOP SANDING UP

Ask your favorite oil field supplier for more information or write to Edward for Catalog 12-S.

Edward Valves, Inc.
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Subsidiary of ROCKWELL MANUFACTURING COMPANY
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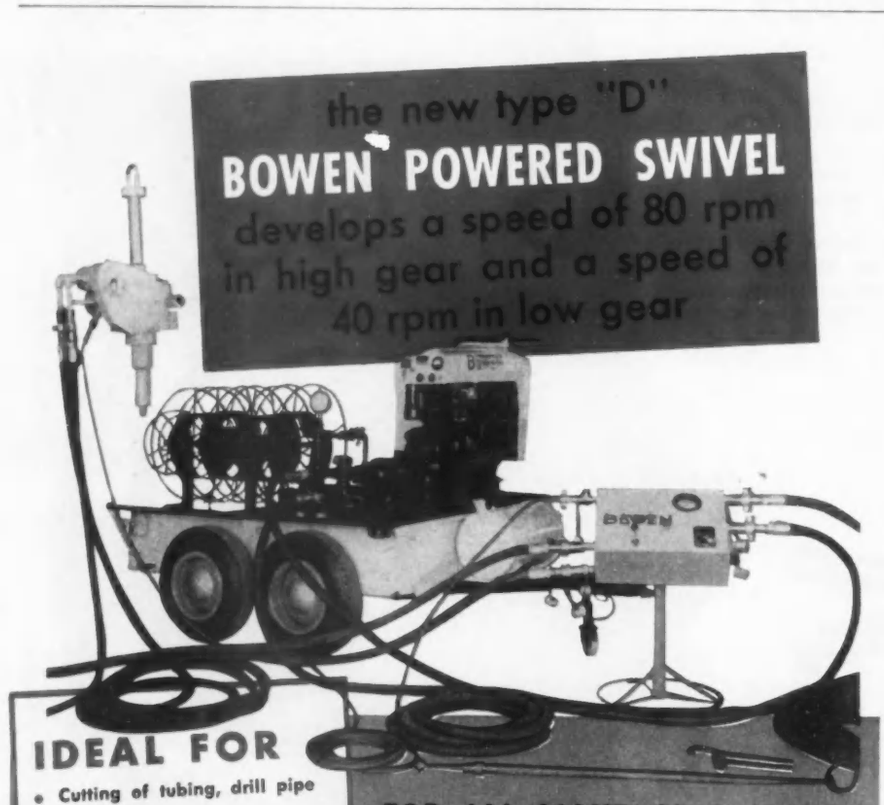
New Books, Maps and Movies

PETROLEUM REVIEW, CRANE COUNTY, TEXAS, Phifer Petroleum Publications, P. O. Box 20,024, Houston 25. $10.

Seventy oil fields have been discovered in Crane County since 1926, producing over 375 million barrels of oil. The discovery well and pertinent information, location of the field, rules and regulations, number of producing wells at the end of the year, and production record are some of the highlights in the development of each field the book outlines. Illustrations include a county map with the fields in color, a new geological chart, logs of discovery wells and 13 field structure maps. This new reference book is the fourth in a series covering oil and gas production in the West Texas Permian Basin. Previous volumes dealt with Andrews, Gaines and Ector counties.

The information was compiled by Robert L. Phifer from the records of hearings on the fields held by the Railroad Commission of Texas.



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- Scraping casing
- Drilling out cement
- Milling operations
- Backing out strings of rods, tubing, etc.
- Drilling rat holes
- Drilling out inside of drill pipe after a fire or other shut down time
- Milling out undersize I.D. of drill pipe tool joints to allow passage of cutters, etc.
- Maintaining circulation and rotation to prevent sticking of pipe while repairs are being made to the drilling rig.

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Bowen Powered Swivels eliminate the necessity of moving in kellys, rotary tables or other heavy equipment for light or medium short-time rotary work. They are sensitive enough for small torque operations like cutting with macaroni or sucker rods, yet sufficiently rugged to do clean-out and milling jobs.

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OIL AND GAS WELLS IN WESTERN CANADA, Nickle Map Service Ltd., Calgary, Canada. $20.

The 37 maps in this new quarterly publication cover an area of nearly 400,000 square miles from Manitoba across Saskatchewan and Alberta to northeast British Columbia. On a scale of 12 miles to the inch, these maps are reductions of the normal four miles to one inch Airsurvey Controlled Maps and are intended to supplement regular office use of the larger scaled maps. The four miles to one inch maps are kept under daily revision.

All wells are classified to show the state of drilling or type of production. Wells outside of field areas are named and numbered.

The publication is complete with an index to maps and an alphabetical list of over 400 oil and gas areas in Western Canada. There are also detailed instructions on how to read a Western Canadian map.

•

GEOLOGY OF SOUTHERN CALIFORNIA, Department of Natural Resources, Division of Mines, Ferry Building, San Francisco 11. $12.

Compiled and edited by Professor Richard H. Jahns of the California Institute of Technology, the bulletin is essentially a gigantic symposium on the geology of southern California. Containing 441 text figures, an index map, 60 route maps to selected geologic trips and 34 map sheets with texts and illustrations, the book is the product of 103 technical experts in academic, industrial and governmental positions. Each of the ten chapters and preface are bound separately. Five road logs also are separately bound, and map sheets are encased in an expanding envelope. One large map showing the geology of the Los Angeles Basin, lithographed in color, may be purchased separately.

•

GAS FACTS, Bureau of Statistics, American Gas Association, 420 Lexington Avenue, New York 17. $2.

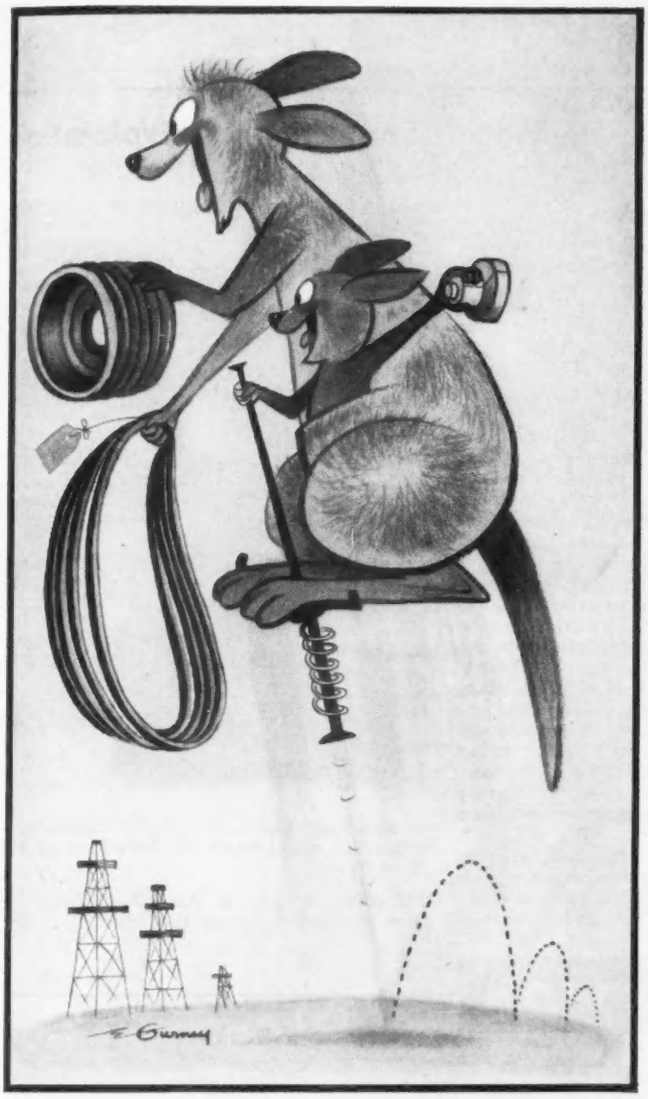
The 1955 edition of the annual statistical yearbook of the American Gas Association contains 1954 statistics on the gas utility and pipe line industry, including information on energy reserves, production, transmission and distribution, underground storage, sales and utilization, finance, labor, prices and a brief section of Canadian statistics.

Features not included in earlier editions are a separate income statement and balance sheet for pipe line companies from 1941 to 1954; additional statistics on exploratory drilling for natural gas and/or oil; detailed tables showing appliance shipments, and tables showing, for selected cities, cost of residential heating fuels since 1941, with suggested fuel efficiency factors.

•

THE GAS DATA BOOK, Bureau of Statistics, American Gas Association, 420 Lexington Avenue, New York 17. 50 Cents.

A condensed summary of gas industry statistics, this pocket-sized publication is intended for easy reference to basic gas industry facts. Containing historical information on the principal measures of industry growth, the booklet provides a convenient summary of the more detailed information contained in "Gas Facts."



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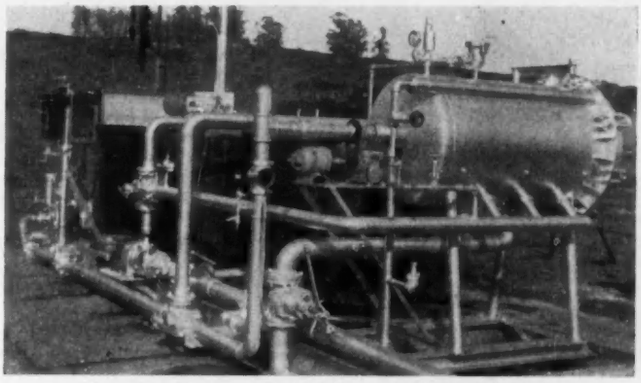

Hercules Pressure Leaf Filter—field installation.

To remove oil, algae, bacteria, iron and turbidity from oil well flood water, leading producers are using Hercules Pressure Leaf and Sheet Filters. Included are such operators as

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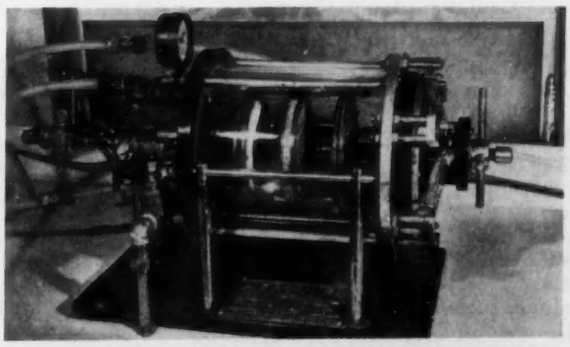

Hercules Pressure Leaf Filter—field laboratory test model.

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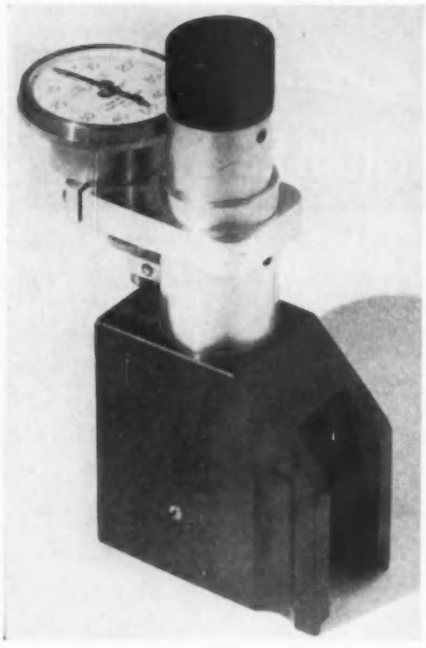


Measuring Instruments

P & G Manufacturing Company has announced that two new model valve-gappers are available which make micrometer accurate valve clearance adjustment possible on all model Cummins diesel engines. Both instruments utilize a patented method of measuring the exact valve clearance with a dial indicator which is graduated in .001 inch. This method of measuring valve gap permits a positive visual reading of the valve clearance before, during and after readjustment, regardless of wear on the valve stem or rocker arm. One model is designed specifically for use on the H and J series Cummins engines; the other, for use on all HT and NH series engines.

For more data, circle **No. E1** on Readers' Service Card, last page this issue.

Safety Device

The New Deal Specialty Company, Inc., of Okmulgee, Okla., has introduced the Short Stop, a safety device designed to restrict travel of either a nail or stem in a shear relief valve. After extensive field testing, it has been found that this device facilitates rapid replacement of sheared nails and rapid valve servicing, yet the rugged protective case insures safe working conditions in the vicinity of a shear relief valve.

For more data, circle **No. E2** on Readers' Service Card, last page this issue.

Electric Fork Trucks

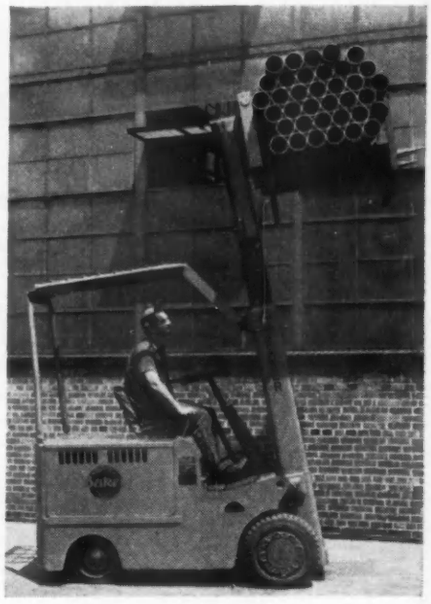
A new line of electric fork trucks designed for high maneuverability, ease of maintenance and increased operator comfort and convenience has been introduced by the Baker-Raulang Company. The new Model FT line includes trucks with 3000, 4000 and 6000-pound capacities.

The FT trucks have high stability, due to low center of gravity, increased width and low overhang. The turning radius for the 3000-pound truck, however, is only 73½ inches, minimum intersecting aisle is 66½ inches and clearance for right-angle turn is 87 inches exclusive of load length.

The Model FT trucks have no cowl and the floor plate has been kept free of obstructions for safety and operator comfort. Controls, including controls for auxiliaries, are conveniently located and easy to actuate. The steering mechanism is designed to require minimum operator effort.

The Model FT trucks have three braking systems. The wheel brakes are hydraulic, self-energizing and self-equalizing. The parking brake, actuated by the spring seat, acts on the armature shaft. The trucks also have dynamic braking, with a feature preventing abrupt reversal of direction while truck is in motion.

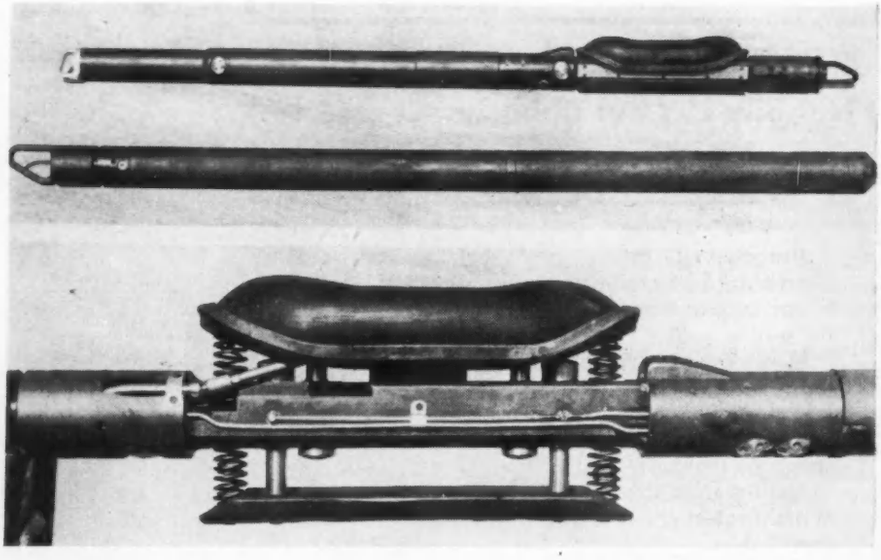
All components have been located for maximum accessability for maintenance. Hydraulic brakes are adjustable without removing the wheels. Convenient location



of hydraulic valves means that additional valves for attachments can be added easily in the field.

For more data, circle **No. E3** on Readers' Service Card, last page this issue.

PRODUCTION



Formation Tester

Schlumberger Well Surveying Corporation has placed on the market the first formation fluid testing and sampling tools to be operated on an electric cable.

Two tools have been developed—the formation tester and the fluid sampler. Both are designed to obtain samples of reservoir fluid from potential oil or gas horizons. In addition, the formation tester will measure formation pressure on a surface recorder.

The tools are designed to operate in a bore hole with a full column of drilling mud. For this reason they are expected to be particularly valuable in testing forma-

Save time! Keep informed! Circle numbers on Readers' Service Cards, last page this issue.

CF&I

CASING *and* TUBING *is straight and "true"*

CF&I Seamless Oil Country Casing and Tubing is drift-tested to ensure straightness and accurate inside diameter.

CF&I's automatic drifter passes a long mandrel through each pipe to assure proper size. The mandrel, slightly smaller than the nominal inside diameter of the pipe, detects any variations in straightness or possible foreign matter . . . which are corrected before the casing or tubing passes this phase of inspection.

Drifting is only one of many tests conducted by CF&I to ensure that all seamless casing and tubing meets *or exceeds* the exacting API standards. Other tests include X-ray inspection, thread gauging, hydrostatic pressure tests and overall visual inspection.

CF&I Seamless Oil Country Casing and Tubing meets API STD 5A specifications—in sizes from 2⅜" O.D. through 9⅝" O.D.

3480

SEAMLESS TUBULAR PRODUCTS

THE COLORADO FUEL AND IRON CORPORATION
Denver, Colorado

CF&I

tions in the deep wells common to the Gulf Coast.

The formation tester, like drill stem testing tools, functions best in the more firm formations since very soft formations often fail to provide an effective seal against the drilling mud. Though not yet fully tested under all conditions, the tester offers good possibilities even in hard sandstones and limestones.

The significant advantages of the new testing method are summarized by the Schlumberger engineers as follows:

1. Like electric logging, side-wall coring, and other logging techniques, they offer an added method of evaluating productive possibilities after the well is drilled through the prospective oil or gas horizons.

2. They effect great savings in rig time, materials and wear on equipment.

3. They increase safety from blowouts since testing can proceed with a full column of mud in the hole.

4. They give samples which can be analyzed to establish identity of reservoirs and to determine the quality of the product.

5. Through multiple pinpointed tests in a producing zone they can provide a productivity profile by which the completion may be guided to obtain greater ultimate recovery.

(This item supplements Schlumberger Well Surveying Corporation data on Pages 4449-4472 of the Composite Catalog, 20th Edition.)

For more data, circle **No. E4** on Readers' Service Card, last page this issue.

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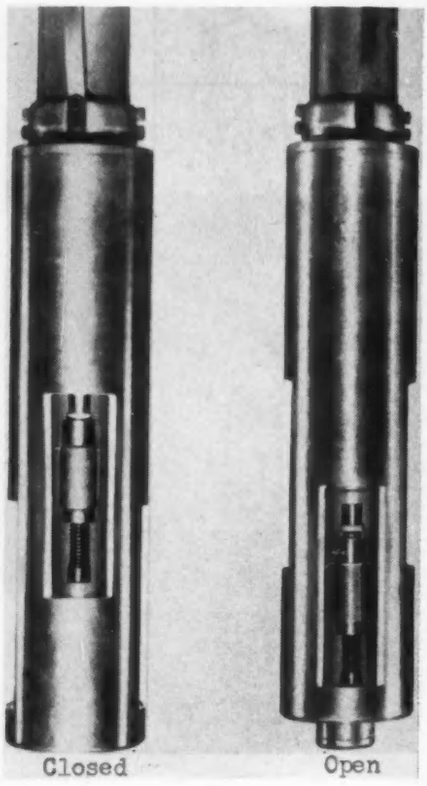
For over 60 years Manufacturers of Spang Weldless Jars and a Complete Line of Cable System Drilling and Fishing Tools for Oil and Gas Wells, Prospect Drilling and Shot Blast Holes.



Completion Valve

A new CTI completion valve has been introduced which eliminates swabbing, allows perforation without hydrostatic head and without pressure on the formation, allows fracturing or acidizing through the valve, and can be run with or without water blanket.

Adaptable to most packer assemblies, the CTI completion valve has an aluminum plug at the bottom of the mandrel, held in place by the friction of O-Ring packing. This plug prevents the fluid in the well from entering the tubing string until you are ready to knock out the plug.

The valves will not open until the packer is set. As the packer is set, the packer mandrel moves down, forcing the valve mandrels down against the valve shoulder, compressing the springs. This forces the valve mandrels off the test seats and allows the fluid to flow through the valve body parts, equalizing the hydrostatic pressure below the packer into the tubing string.

With the pressure equalized the weight of the sinker bar on the perforating line against the plug will knock it out.

Should it become necessary to squeeze a well because of high gas-oil ratio, or water intrusion, this tool can be run to determine if there is a shut-off. If so, it is possible to perforate through the CTI completion valve for re-completion.

For more data, circle **No. E5** on Readers' Service Card, last page this issue.

Valve Lubricant Gun

A new, compact, lightweight air-operated lubricating gun designed to meet field and plant maintenance needs, has been introduced by Rockwell Manufacturing Company.

The "Hypregun" weighs only 39 pounds and operates on air pressures up to 150 psi. It is recommended especially for large-scale valve lubricating in refineries, compressor stations, gasoline plants, cycling

plants, pipe lines and christmas tree installations.

A specially-designed air motor and double piston construction provides the self-priming action, a new feature of the gun.

(This item supplements Rockwell Manufacturing Company data on Pages 1454-1457 and 3629-3664 of the Composite Catalog, 20th Edition.)

For more data, circle **No. E6** on Readers' Service Card, last page this issue.

Combination Timer

A new combination timer eliminating the need for separate sequence timer, undervoltage relay and program timer has been incorporated into G-E oil-well pumping starters equipped for automatic sequence restarting, according to the General Electric Company's General Purpose Control department.

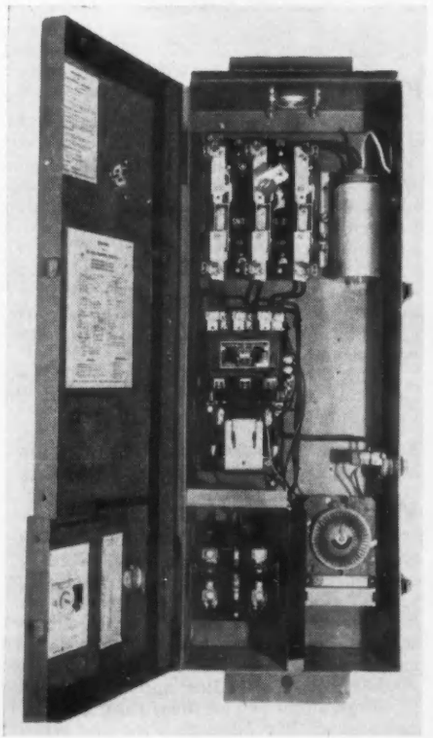
The new combination timer provides automatic sequence restarting after power failure, undervoltage protection, and timing of the pumping cycle. Designed specifically for oil well pumping, the timer can be set for pumping periods as short as 15 minutes.

Restart after power failure is controlled by a momentary contact in the timer, which is closed only a few seconds out of every four minutes. The pumping motor will start only if this contact is closed when power is restored and the program time setting calls for pumping. No adjustments are required nor is a separate sequence timer necessary.

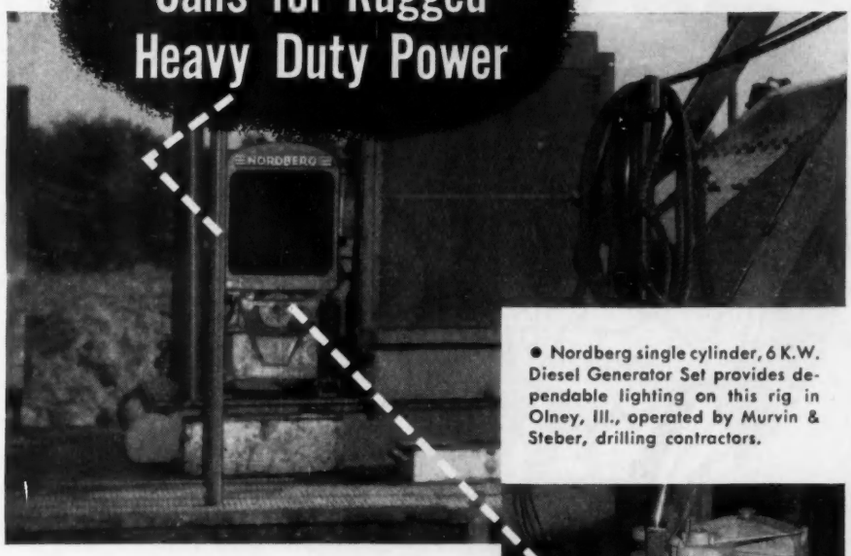
Undervoltage protection also is provided by the momentary contact on the timer. If the voltage is low, the line contactor will not pick up, since the timer automatically tests the voltage every four minutes. When line voltage is sufficient to resume pumping, the timer allows the contactor to restart the motor.

(This item supplements General Electric Company data on Pages 1829-1848 of the Composite Catalog, 20th Edition.)

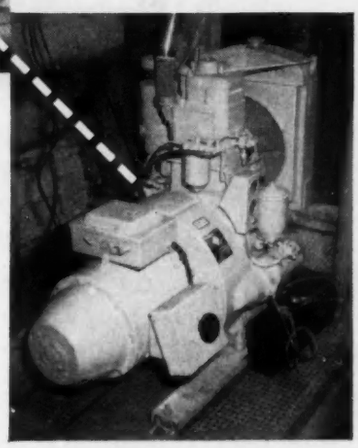
For more data, circle **No. E7** on Readers' Service Card, last page this issue.



RIG LIGHTING
Calls for Rugged
Heavy Duty Power



● Nordberg single cylinder, 6 K.W. Diesel Generator Set provides dependable lighting on this rig in Olney, Ill., operated by Murvin & Steber, drilling contractors.



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Built in 1, 2 and 3-cylinder sizes, *Power Chief* engines develop from 10 to 45 hp, 6 to 30 kw—all available with special vibration-proof mounting for rig installation.

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(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

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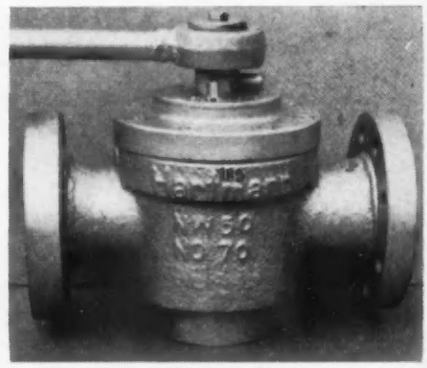


Plug Type Valve

Werner Hartmann of Hannover are now in production on the Hartman plug type valve of cast steel, forged-and-welded or all forged construction for working pressures of from two to five thousand pounds. Recommended as being suitable for extreme service conditions, the valves are anti-friction bearing equipped, have stainless steel seats and corrosion-resistant packing; require no lubrication and operate by a 90-degree turn of the lever.

For more data, circle **No. E8** on Readers' Service Card, last page this issue.

Pigtail Wiper

The PB division of Byron Jackson Company announces a new pigtail sucker rod wiper rubber with a free-winding wiping action which allows it to adapt itself automatically to different rod sizes. An adapter ring enables the wiper rubber to fit existing housings. One wiper insert serves all sucker rod sizes, including tapered strings and macaroni tubing. Since it is not necessary to change wiper rubbers on these combination strings, important time-and-work savings are realized.

(This item supplements Byron Jackson Company data on Pages 929-980 of the Composite Catalog, 20th Edition.)

For more data, circle **No. E9** on Readers' Service Card, last page this issue.

Wire Line Service Unit

For the offshore drilling industry, McCullough Tool Company has completed a new marine wire line service unit which revolves on a circular track mounted on a barge. Being able to turn a full 360 degrees, the unit can efficiently service a well from any desired angle. The service unit has 20,000 feet of wire line and includes electronic equipment and measuring devices to perform all McCullough wire line services

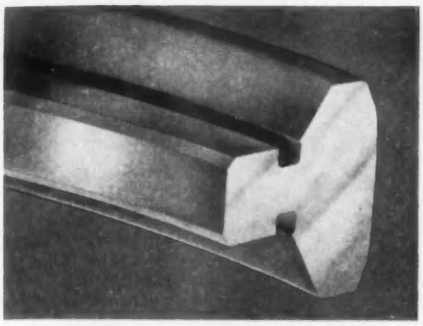
and radioactive logging.

The diesel generator furnishes power for all electronic equipment as well as power for the houses, tool units and flood lights. One of the houses on the barge is fully-equipped living quarters for the crew; the other house includes tool room, work shop and radiation logging instrument room.

The barge is 100 feet long and 26 feet wide. A tug tows it to rig locations picks it up again after the job has been completed.

(This item supplements McCullough Tool Company data on Pages 3093-3132 of the Composite Catalog, 20th Edition.)

For more data, circle **No. E10** on Readers' Service Card, last page this issue.



Stud Bolt and Seal Ring

Cameron Iron Works, Inc., has developed two new accessories for use with extremely high pressure well head connections ranging up to 15,000 pounds working pressures, a torque-indicating stud bolt and a pressure-energizing seal ring.

The Cameron high pressure seal ring is a pressure energizing ring gasket which fits in the standard 23-degree angle API groove preparation. It is somewhat taller than a standard API ring and is reinforced by an internal web.

The Cameron indicator stud bolt accurately indicates proper tension exerted on the bolt for a particular application. The stud bolt is drilled through on center and a rod, the diameter of which allows easy movement in the drilled hole, is inserted in the bolt and welded at one end. The other end of the rod is ground in such a way that a small section projects from the end of the stud when the stud is free. The stud bolt elongates under tension as the nuts are tightened. When the bolt is stretched to the proper amount of tension for the particular application intended, its end becomes flush with the end of the rod. This position can be accurately determined by feel, since the finger tips are sensitive within a thousandth of an inch on this type of flush pin arrangement.

(This item supplements Cameron Iron Works, Inc., data on Pages 1005-1076 of the Composite Catalog, 20th Edition.)

For more data, circle **No. E11** on Readers' Service Card, last page this issue.

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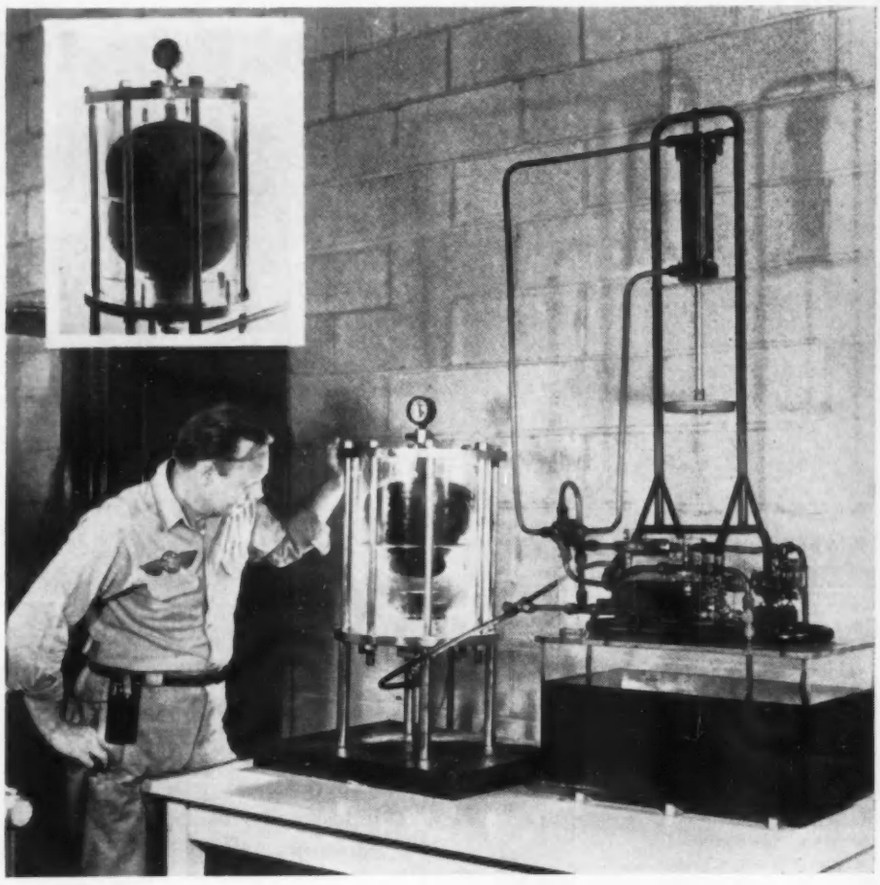

Hydro Pneumatic Accumulators

Oil industry people attending trade meetings this fall will see for the first time a completely visual demonstrator unit showing how hydro pneumatic bladder accumulators work when applied to oil field blowout preventer closing units or to slush pumps.

The bladder-type accumulators are also by their nature adapted to surge or pulse dampers. The exhibit pictured is sponsored by Greer Hydraulics, Inc., and Stewart & Stevenson Distributing Company. Greer pioneered, and designs and produces hydro pneumatic accumulators incorporating a rubber bladder component. Stewart & Stevenson has adapted the device to the Koomey blowout preventers, and also distributes the Greer accumulators for applications on oil well slush pumps.

Made of transparent plastic tubing and components in the experimental shops of Greer's new plant at Idlewild Airport, Jamaica, N. Y., the demonstrator employs a reservoir and gas system to exhibit the action of a 2½-gallon accumulator bladder as the device would be applied to oil field equipment.

For more data, circle **No. E12** on Readers' Service Card, last page this issue.

Fluidrill

Directo Corporation's new 12¼-inch Fluidrill reduces costly rig vibrations as much as 90 percent while drilling the intermediate hole. It enters the string like a drill collar subbing directly to the bit. Utilizing the mud pressure and a 2½-foot stroke telescoping barrel, the new tool maintains a constant pressure on the bit and keeps it firmly seated and working at all times. In addition to the stabilizing effect, the Fluidrill has proved, through alternate runs with conventional strings in the same formations, to drill straighter, cleaner holes.

For more data, circle **No. E13** on Readers' Service Card, last page this issue.

Shock Drill Adapter

Cable type drilling of oil and gas promises to reach a new high in speed and efficiency through perfection of the Koeln Shock Drilling Corporation's 1-2 shock drill adapter. The device is a mechanism which conveys a heavy percussion blow directly to the bit immediately following the gravity blow.

A hydraulic lock and release block device developed by Missouri Research Laboratories, Inc. expressly for the adapter, has successfully solved the terrific load problems occurring as a result of the two practically simultaneous blows.

For more data, circle **No. E14** on Readers' Service Card, last page this issue.